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## Overview



### What's New for The MacBook Pro (Retina, 15-inch, Mid 2015) :

- **Processor:** 2.2Ghz, 2.5Ghz, or 2.8GHz Intel quad-core i7 processors
- **Retina Display:** 15.4-inch (diagonal) Retina display with higher efficiency LEDs
- **Memory:** 16GB onboard, not user installable
- **Storage:** 256GB, 512GB, 1TB flash storage
- **Graphics:** Haswell Iris Pro Graphics (Integrated Graphics)
- **Trackpad:** Force Touch trackpad technology

### Diagnostics:

- Apple Service Toolkit version 2 (AST 2)
- The [Trackpad Calibration Check](#) must be performed after every repair

### The MacBook Pro (Retina, 15-inch, Mid 2012, Early 2013, Late 2013, Mid 2014) computers feature:

- **Processor:** For Mid 2012 model: 2.3GHz, 2.6GHz, or 2.7GHz Intel quad-core processors; For Early 2013 model: 2.4GHz, 2.7GHz, or 2.8GHz Intel quad-core processors; For Late 2013 model: 2.0GHz, 2.3GHz, or 2.6GHz Intel quad-core processors; For Mid 2014 model: 2.2Ghz, 2.5Ghz, or 2.8GHz Intel quad-core processors
- **Retina Display:** 15.4-inch (diagonal) high-resolution Retina display (2880-by-1800 resolution, 220 ppi); Late 2013 and

Mid 2014 models include high-efficiency LEDs

- **Memory:** 8GB or 16GB on board, not user installable
- **Storage:** 256GB, 512GB, 768GB (not available for Late 2013 and Mid 2014 models), or 1TB (available for Late 2013 and Mid 2014 models) SSD card or flash storage (beginning in 2013, "flash storage" is the approved term for use in the following product families: MacBook Air, MacBook Pro with Retina display)

## Important Service Considerations

The MacBook Pro (Retina, 15-inch, Mid 2012, Early 2013, Late 2013, Mid 2014, Early 2015) design requires special service considerations:

- **Battery Service:** The battery is not a replaceable part. Never remove the battery from the top case. To replace a battery, you must replace the top case.
- **Battery Safety:** Before beginning any repair procedure, install the battery cover and disconnect the battery cable from the logic board.
- **Top Case:** The top case comes with the battery, keyboard, trackpad, microphone, clutch screw covers, and fan ducts.
- Returned top cases must be packaged according to strict guidelines. If the battery, keyboard, or trackpad must be replaced, you must replace the top case. The microphone, clutch screw covers, and fan ducts are separate, replaceable parts.
- **Trackpad Calibration Check (Mid 2015 Only):** The calibration of the Force Touch trackpad must be verified after every repair.
- **Wireless Card:** The wireless card comes with a gasket attached to the underside. When lifting the card from the logic board, check that the gasket remains with the card. The gasket is available as a separate service part (923-0150).
- **I/O Board Cable Guide:** A cable guide is attached to the I/O board. Cables should be routed back into the guide after reinstalling the board. Replacement I/O boards do not come with the cable guide; it must be transferred from the original to the new board. The guide is also available as a separate service part (923-0110).
- **Right and Left Speakers:** The right and left speakers are paired and only offered as a kit. If you need to replace one speaker, you must replace both. Do not save a used, good speaker for another repair; the speakers are fine-tuned to each other by the manufacturer and will not operate properly if mismatched.
- **Fan Ducts:** The fan ducts are rubber gaskets that sit on top of the fans. They are fragile and held down with adhesive. Use care when lifting them to access the fans.
- **Display Clamshell:** The display clamshell comes with a new set of left and right clutch screw covers.
- **Bottom Case Screws (Late 2013 Only):** During the reassembly process of every service procedure performed on a MacBook Pro (Retina, 15-inch, Late 2013) model, technicians should install the bottom case with new screws from Apple screw kit 076-00003 or with the screws included with the bottom case service part (if replacing the bottom case).
- All screws that originally secured the bottom case should be discarded.

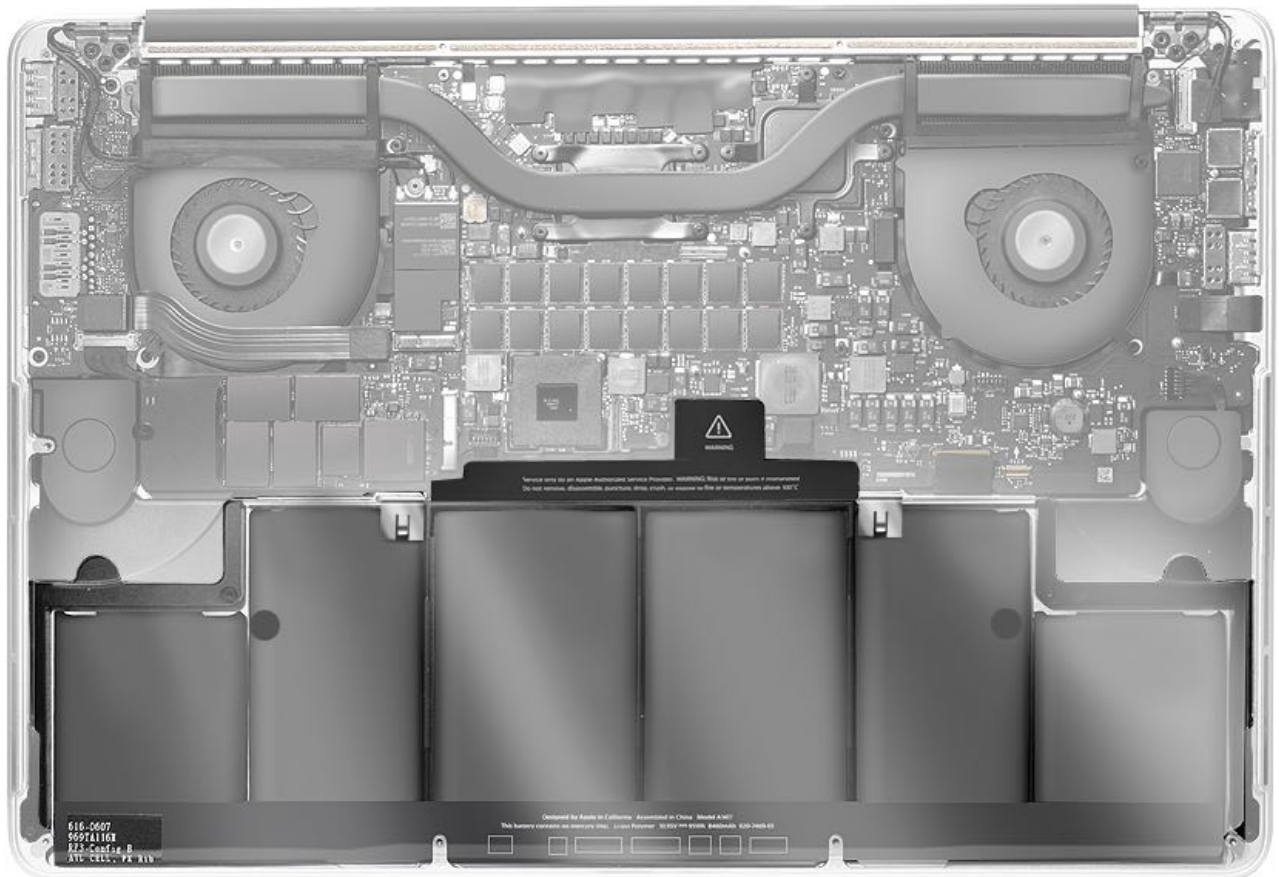
## Starter Kits

The following kits are needed for servicing this computer:

- Battery Safety Kit
  - 923-0089 Battery Cover, Package of two, for Mid 2012 and Early 2013 models
- 923-0706 Battery Cover, Package of two, for Late 2013, Mid 2014, and Mid 2015 models
- 923-0731 Pentalobe Driver

# Battery Safety Precautions

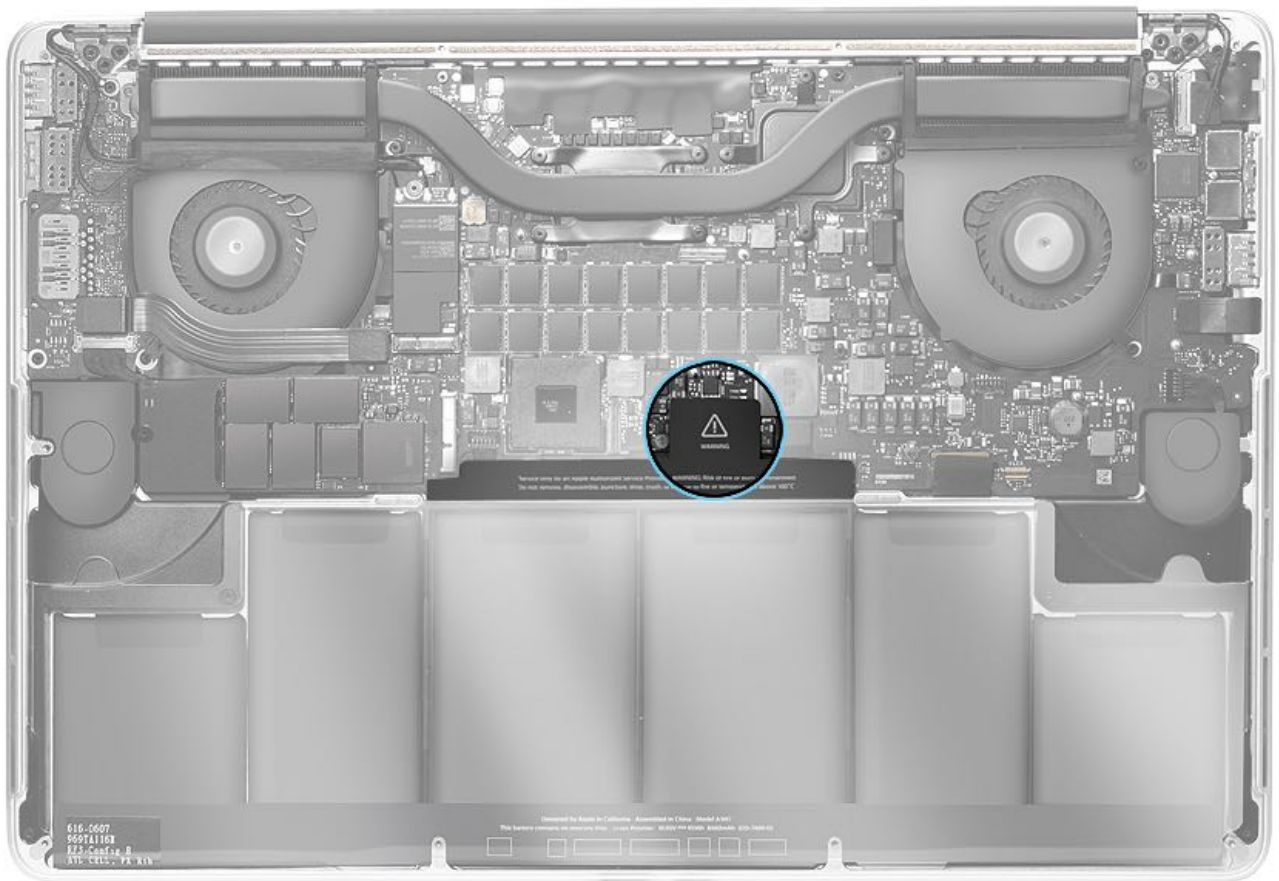
This computer model contains a built-in lithium-polymer rechargeable battery pack that is serviceable by Apple Authorized Service Providers only. The battery is replaceable as part of the top case assembly, but is not offered as a standalone module.



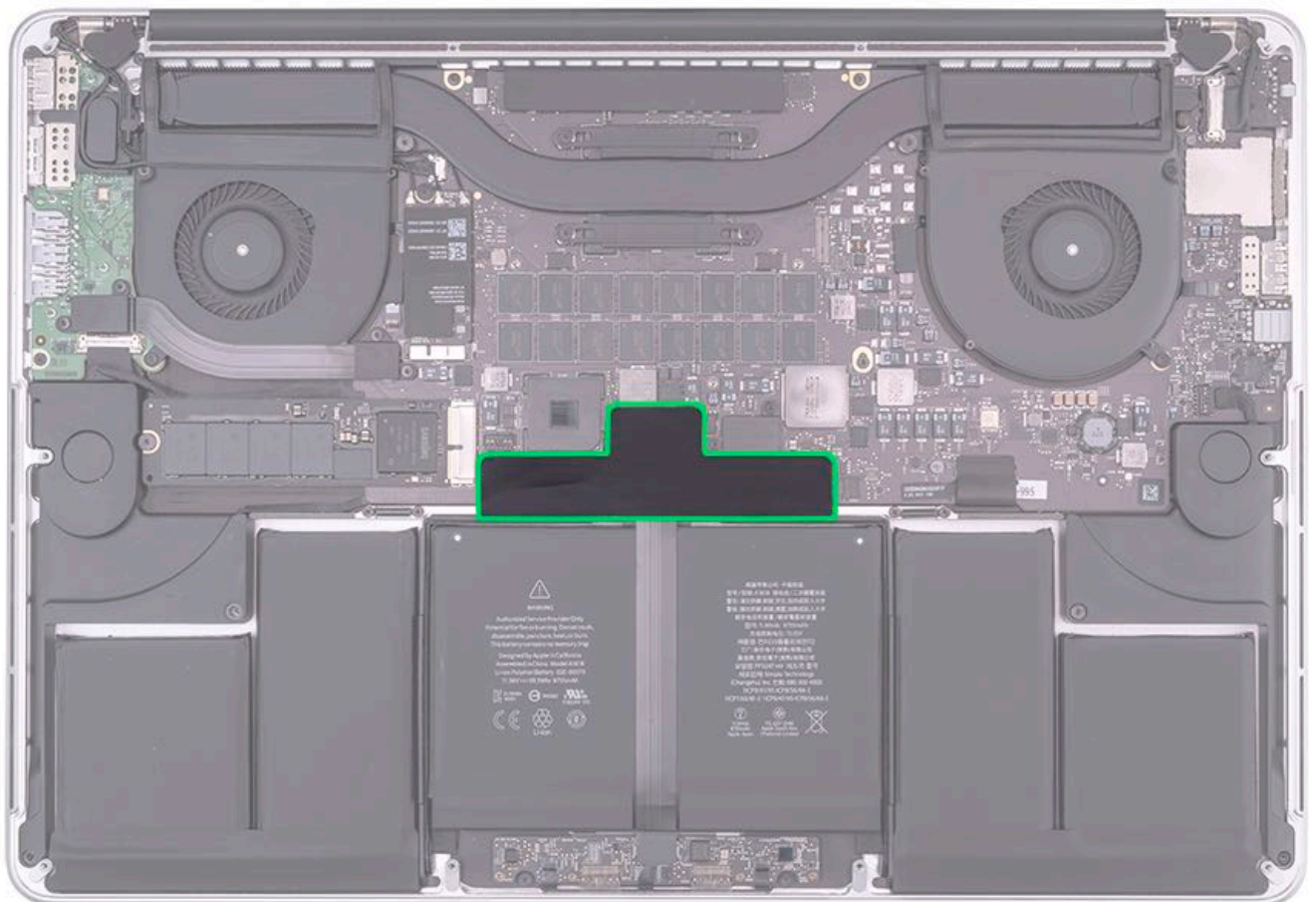
## WARNINGS:

- Every time you remove the bottom case, attach the protective battery cover and disconnect the battery cable from the logic board.
- All work spaces must be free of foreign or sharp materials, and batteries should not be exposed to heat or open flame.
- Do not drop, stack, puncture, crush, flex, or apply unnecessary pressure to a top case battery, as this may result in damage.
- Damage to a battery may result in a potential thermal event.
- The battery is built in and connected to the logic board by a cable. The battery must be disconnected before performing service procedures. If you fail to do so, current from the battery may short-circuit the components and render the logic board and/or the battery cable unusable. Use only a black stick or other nonconductive flat-blade tool.

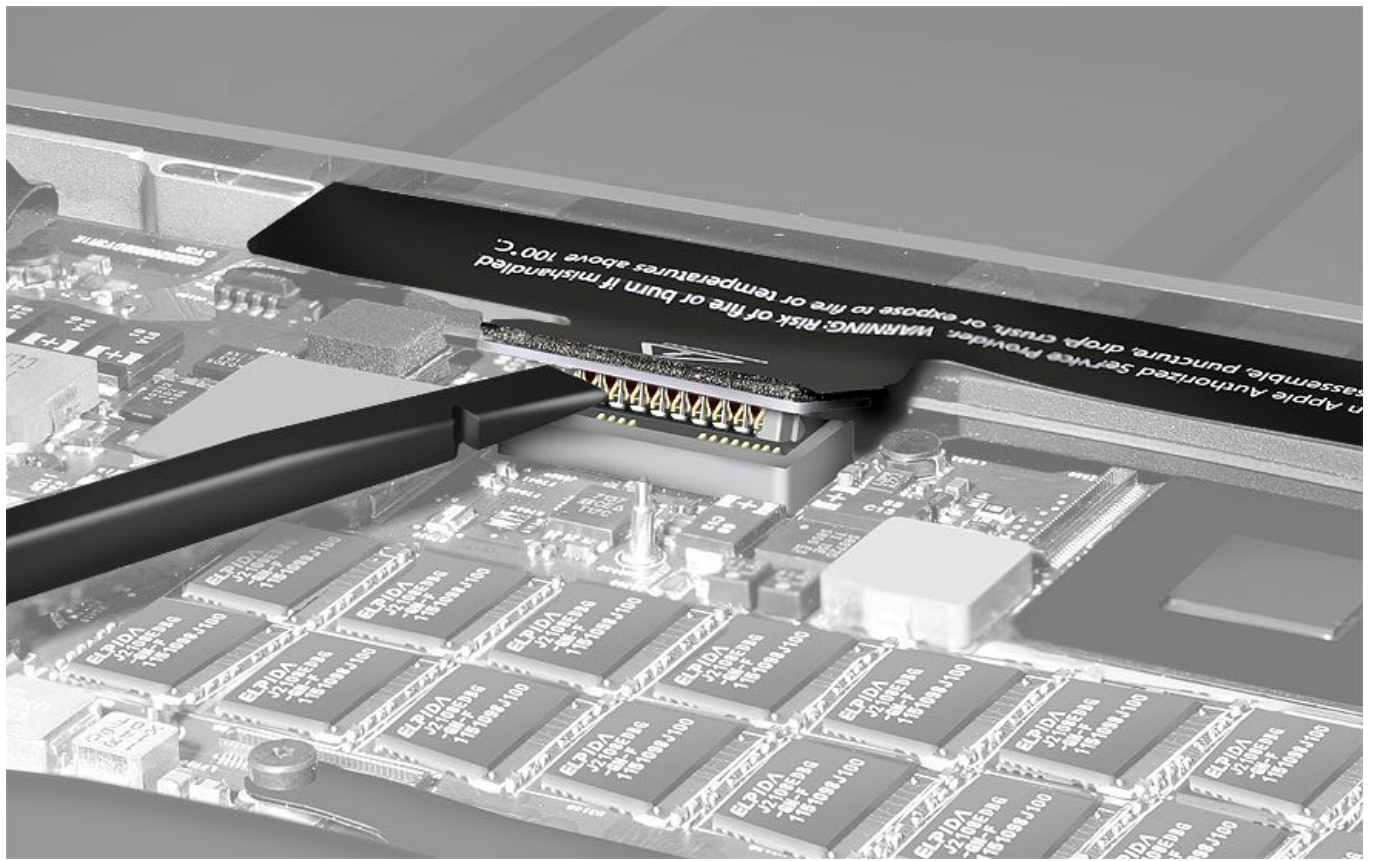




Mid 2015



**Note:** Use only a black stick or other nonconductive flat-blade tool.



# Keycap Replacement

## Topic

Service packages of replacement keycaps are available for MacBook Pro (Retina, 13-inch, Late 2012 to Early 2015) and MacBook Pro (Retina, 15-inch, Mid 2012 to Mid 2015). The packages allow you to replace individual keycaps rather than the entire top case.

The following instructions explain how to remove and replace a keycap and scissor mechanism (plastic piece under keycap that secures keycap to top case) on these computers:

- MacBook Pro (Retina, 15-inch, Mid 2012)
- MacBook Pro (Retina, 13-inch, Late 2012)
- MacBook Pro (Retina, 13-inch, Early 2013)
- MacBook Pro (Retina, 15-inch, Early 2013)
- MacBook Pro (Retina, 13-inch, Late 2013)
- MacBook Pro (Retina, 15-inch, Late 2013)
- MacBook Pro (Retina, 13-inch, Mid 2014)
- MacBook Pro (Retina, 15-inch, Mid 2014)
- MacBook Pro (Retina, 13-inch, Early 2015)
- MacBook Pro (Retina, 15-inch, Mid 2015)

### Notes:

- Keycap kits are available for International English, U.S. English, and Japanese version keyboards.
- A European Special Character kit is available with British (B), German (D), French (F), Danish (DK), Italian (T), Spanish (E), and Swedish (S) specific keycap characters.
  - **Note:** To receive the proper keycaps to complete a single British, German, French, Danish, Italian, Spanish or Swedish keyboard, order both the European Special Character Kit **and** the ISO English keycap kit. Neither kit by itself contains all the keycaps necessary for a single localized keyboard.
- Always shut down the computer before replacing a keycap.

### Identifying Keycaps and Scissors

Eight types of keycap packages are offered based on region and keyboard type (Version D and Version S).

Part Number	Keyboard Type	Language
923-0065	Version D	ANSI English
923-0130	Version S	ANSI English
B923-0065	Version D	ISO English
B923-0130	Version S	ISO English
J923-0065	Version D	Japanese
J923-0130	Version S	Japanese
ZM923-0065	Version D	European Special Character Kit
ZM923-0130	Version S	European Special Character Kit

Although the scissors for both versions D and S keyboards function the same, they have a slightly different design. Be sure to match only Version D keycaps to Version D scissors/keyboards and Version S keycaps to Version S scissors/keyboards.

The photos below identify version D and version S scissors.

### Version D scissors



### Version S scissors



## Keycap Map

The following illustrations summarize the differences in removing keycaps on the MacBook Pro (Retina, Mid 2012) keyboard. For detailed instructions, see the [Procedure](#) section below.

- **Yellow:** No stabilizer bar under key cap
- **Orange:** Hooked stabilizer bar under key cap (two hooked bars under Space Bar)
- **Stripes:**
  - **No Stripes:** Lift key from the lower corners
  - **Stripes:** Lift key from the upper corners

### ANSI English Key Layout

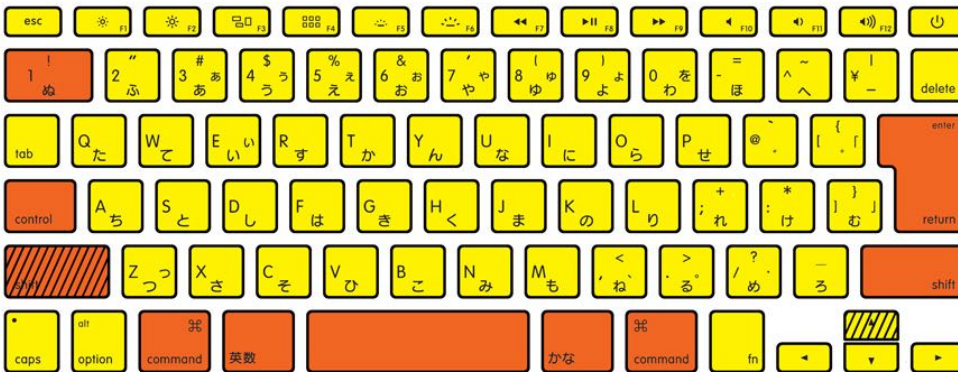


### ISO English Key Layout





## ISO Japanese Key Layout



## Procedure

Use the following steps to remove a defective keycap and replace it with a new keycap and scissors from the service keycap package. When replacing a keycap, replace the scissors below it.

Because the design of the keycap and scissor mechanism differs depending on the shape of the key, the procedure is divided into three parts:

1. [Square keys and small rectangular keys](#) (for example, letters A–Z, numbers, punctuation, function keys, and arrow keys). These use one scissor mechanism beneath the key.
2. [Rectangular keys](#) (for example, Shift, Delete, and Return). These use one or two scissor mechanisms and one stabilizer bar (no stabilizer bar on bottom row for rectangular keys)
3. [Space bar](#). This uses two scissor mechanisms and two metal stabilizer bars.

**Note on illustrations:** Most of the steps are illustrated with version D scissors. However, the steps are the same for version S scissors except where indicated.

**Important:** Shut down the computer before replacing a keycap.

## Removing and Replacing Square Keys and Small Rectangular Keys

1. Pry the key up from the lower edge—first at one corner and then at the other. Exception: Pry the Up Arrow keycap from the upper edge.

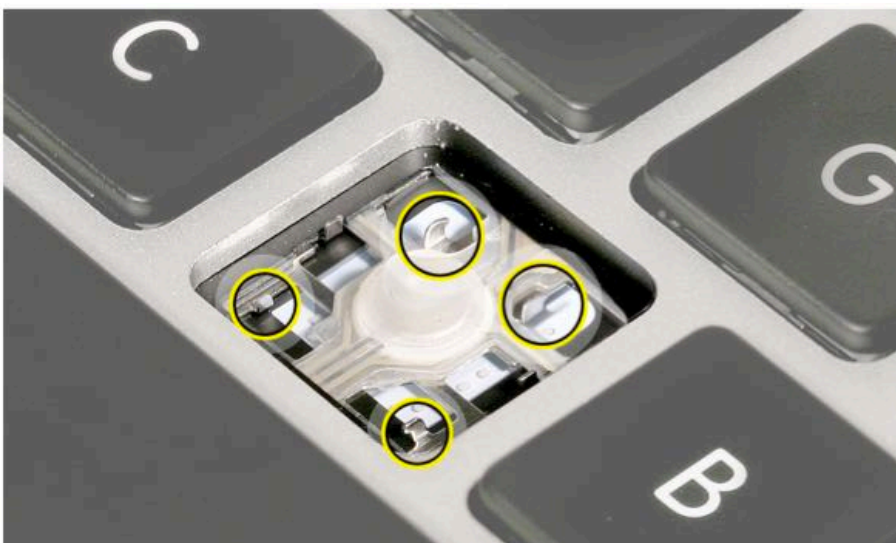


2. Pry and remove the scissor mechanism from the keycap well.



3. Check the rubber dome and raised metal areas inside the keycap well.

- When the rubber dome is pressed and released, it should spring back upright. If the rubber dome is off center or damaged, replace the top case.
- If the metal hook that holds the slider bar of the scissor mechanism is bent, try to bend it back to a uniform 90-degree angle. If it is bent or broken beyond repair, replace the top case.
- If the two metal ears are bent, use needlenose pliers to straighten them. If either or both ears are broken beyond repair, replace the top case.



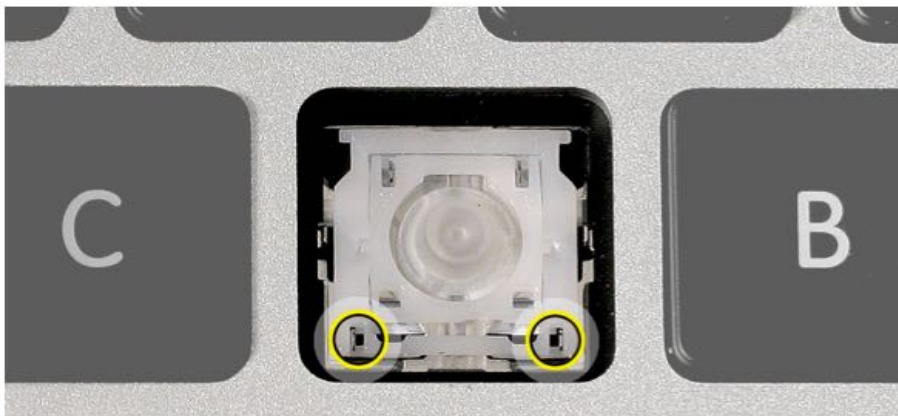
**Note:** To install the replacement scissor mechanism, you must first remove it from the replacement keycap.

4. Position the pointed end of a black stick under both plastic layers on the pin side of the scissors. Pry up and remove the scissors from the keycap.

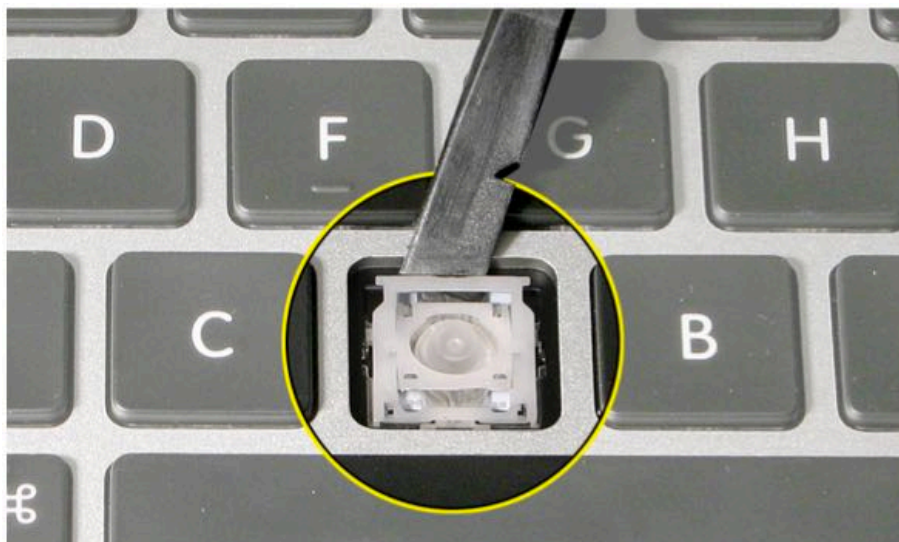


5. To install the replacement scissors in the keycap well, position the scissors so that the smooth side faces up. Holding the scissors closed, fit the two small square openings in the scissors onto the two metal hooks at the lower edge of the keycap well.

6. Press and slide the scissors up until the two rectangular openings in the scissors fit over the two metal hooks at the upper edge of the keycap well.



7. Use a black stick to raise and lower the scissor mechanism to make sure it moves freely.



8. Slide the upper edge of the keycap into the keycap well. Then, press down on the top of the key until you feel it snap into place.









2. Using a black stick, separate the lower stabilizer bar from the keycap.



3. With the lower edge loosened, pry the Space bar from the upper edge. Use a black stick, if necessary, to tilt up and remove the keycap.

**Note:** To fully remove the keycap, you may need to pry it from the top stabilizer bar. Be sure to remove both stabilizer bars from the keycap well.

4. Remove the original scissors and install the replacement scissors. Refer to steps 2–7 under [Removing and Replacing Square Keys/Small Rectangular Keys](#).

### Version D Space Bar Replacement

1. Orient the replacement Space bar so that the slider hooks on the underside of the key are at the lower edge of the key.

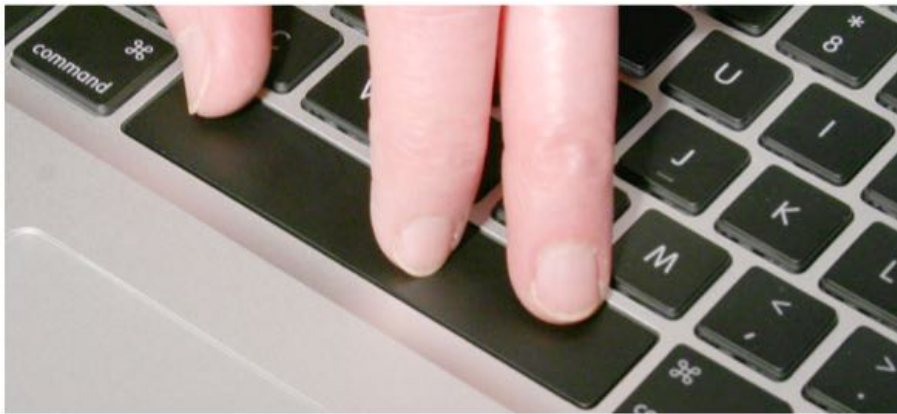


2. Rotate the lower stabilizer bar on the Space bar approximately 90 degrees out from the key and insert the ends of the bar into the two lower metal ears in the keycap well.



3. Insert the ends of the upper stabilizer bar into the two upper metal ears in the keycap well and lower the keycap over the well.

4. Press and slide your fingers along the Space bar until you hear the clips on the top and bottom edges snap into place.



5. Check the key from all angles to make sure it is uniformly flat. Press and release one corner of the key. If the key is installed correctly the opposite corner should respond at the same level (not tilted higher or lower).

### Version S Space Bar Replacement

1. Orient the replacement Space bar so that the slider hooks on the underside of the key are at the lower edge of the key.



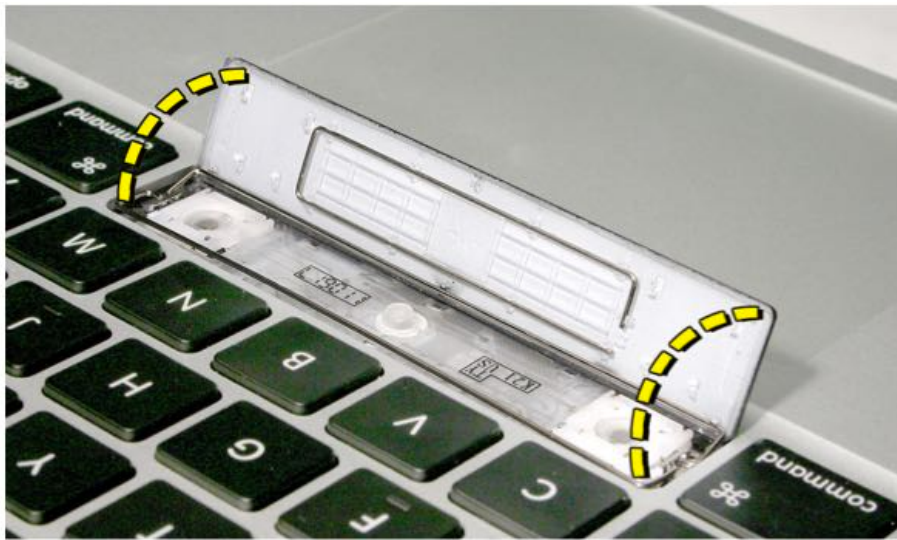
2. Using a black stick, remove the top stabilizer bar.



3. Hook the top stabilizer bar into the upper two metal ears in the keycap well.



4. Rotate the lower stabilizer bar on the Space bar approximately 90 degrees out from the key and hook the ends of the bar into the two lower metal ears in the keycap well.



5. Lower the upper edge of the keycap down into the keycap well.

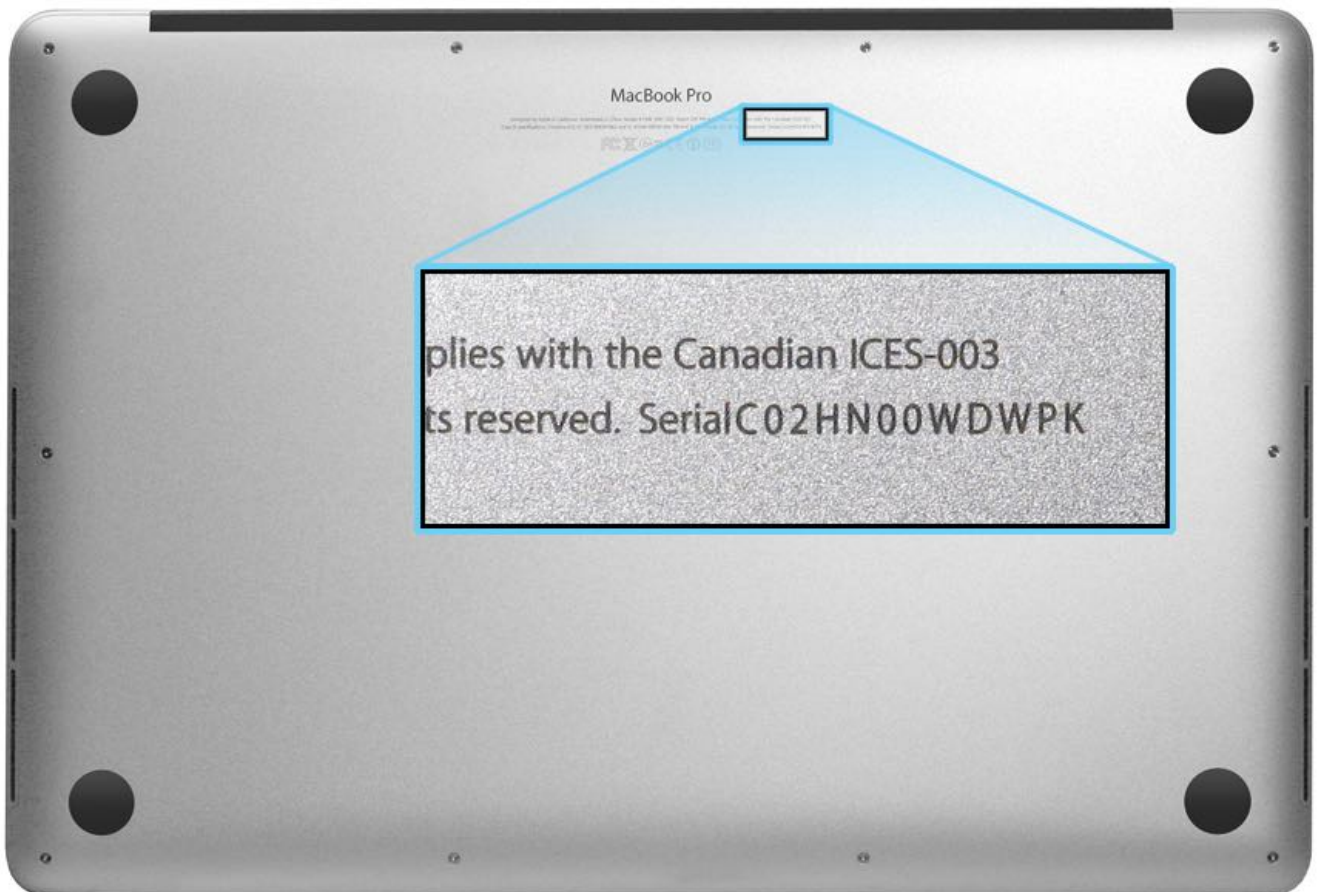
6. Press and slide your fingers along the Space bar until you hear the clips on the top and bottom edges snap into place.

# Serial Number Locations

## System Serial Number

The system serial number is located in two places.

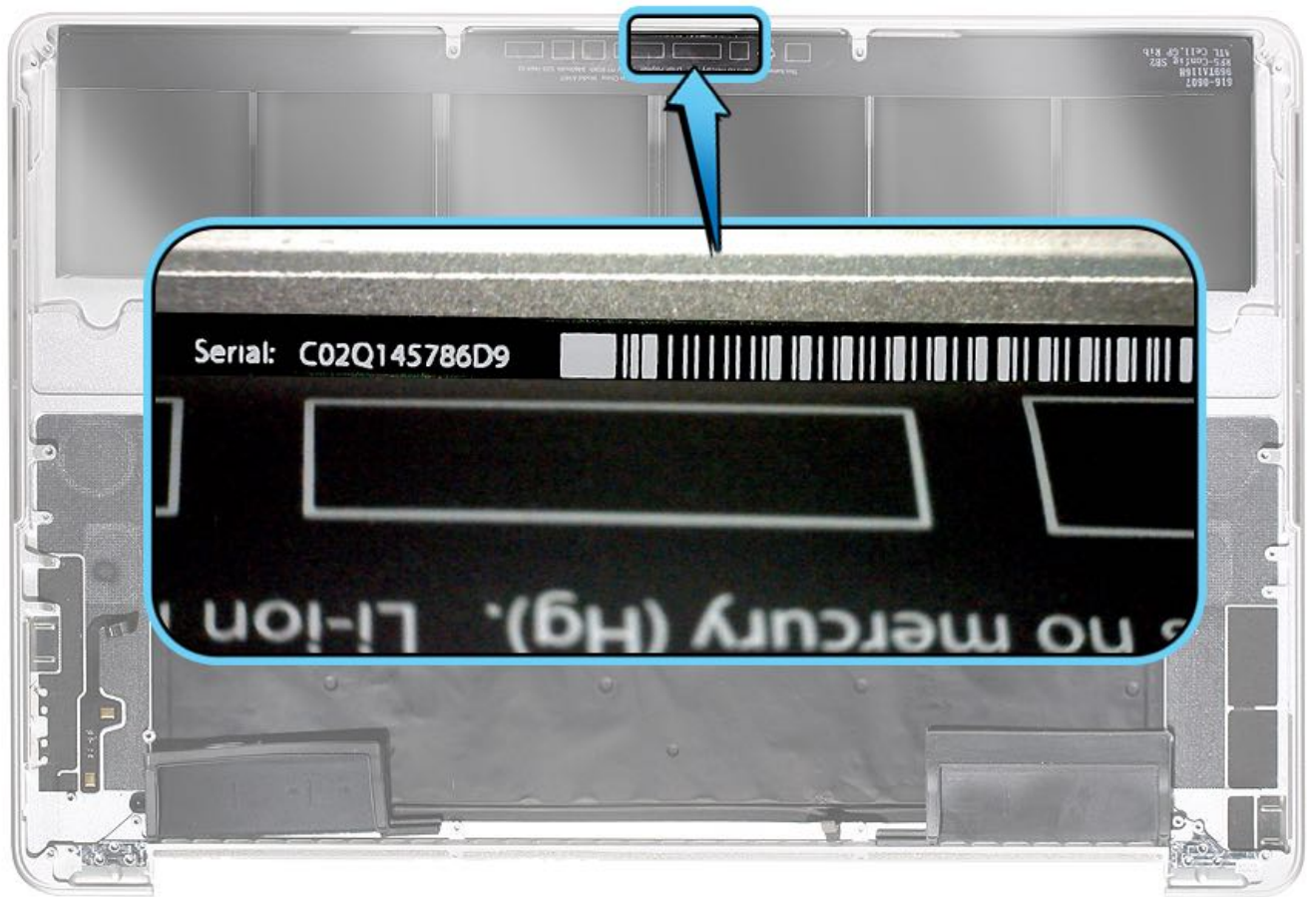
Turn the computer over to see the system serial number etched on the bottom case near the hinge.



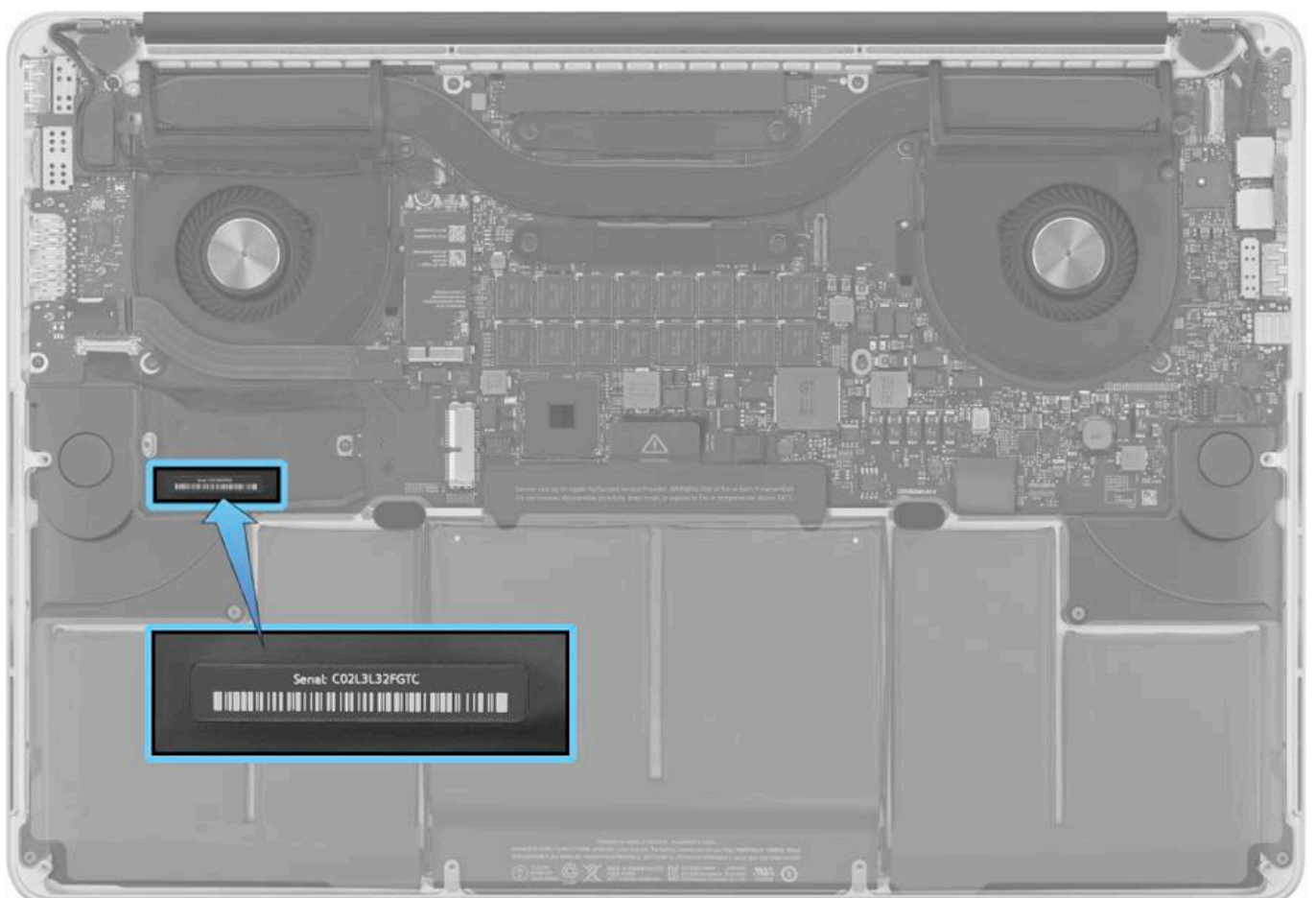
With the bottom case removed, find the system serial number label inside the computer.

**MacBook Pro (Retina, 15-inch, Mid 2012 and Early 2013):** Serial number is at the lower inner edge of the top case.



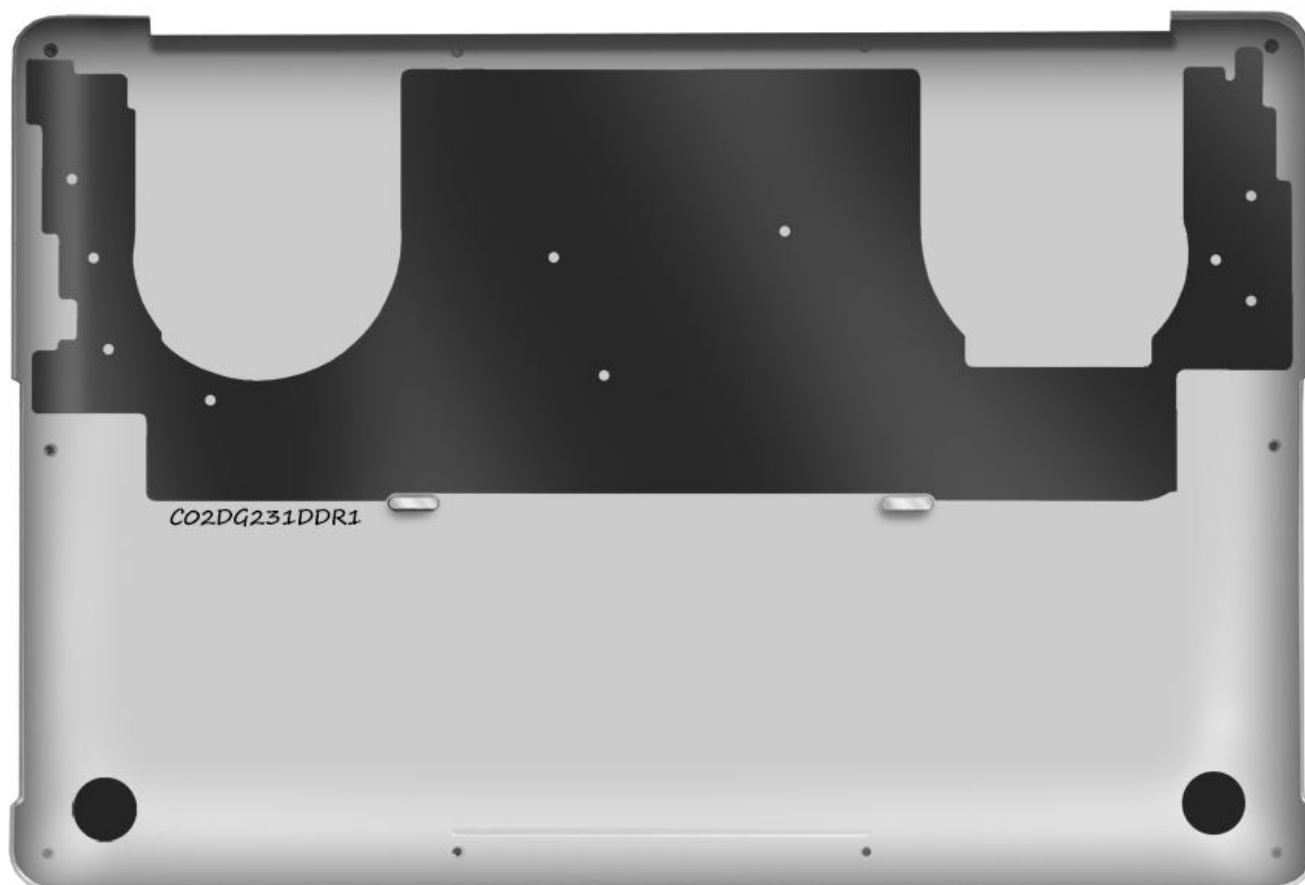


**MacBook Pro (Retina, 15-inch, Late 2013, Mid 2014, and Mid 2015):** Serial number is under the flash storage.



**Transferring the System Serial Number**

When replacing a bottom case, retain the user's original bottom case until the repair is complete. Before installing EITHER a replacement top case or a bottom case, use a fine-tip permanent marker to write the original system serial number inside the bottom case.

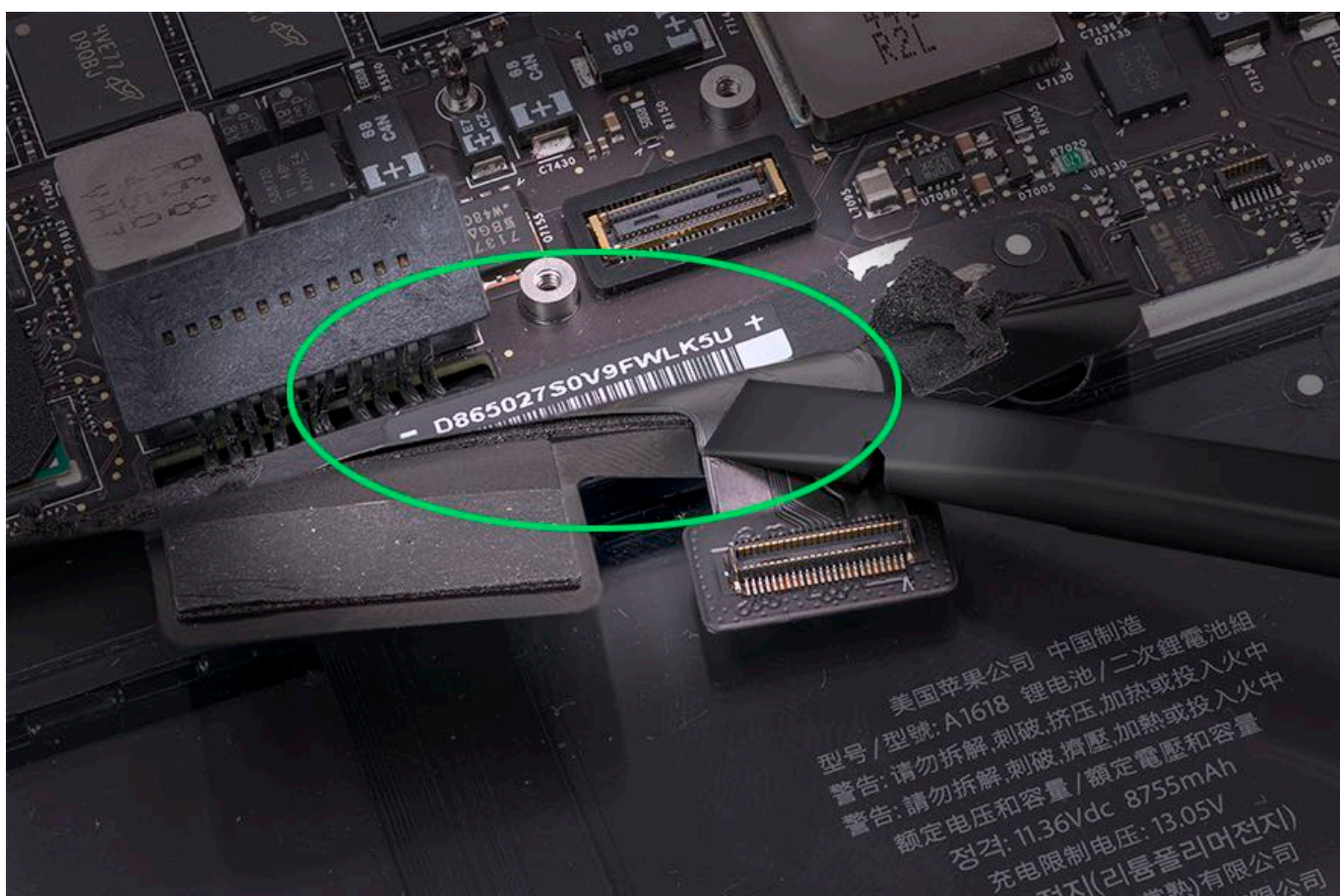


### **Battery Serial Number**

At the top of the battery, turn down the Mylar cover to reveal the battery serial number. Copy the original battery serial number when reporting a top case return to Apple.



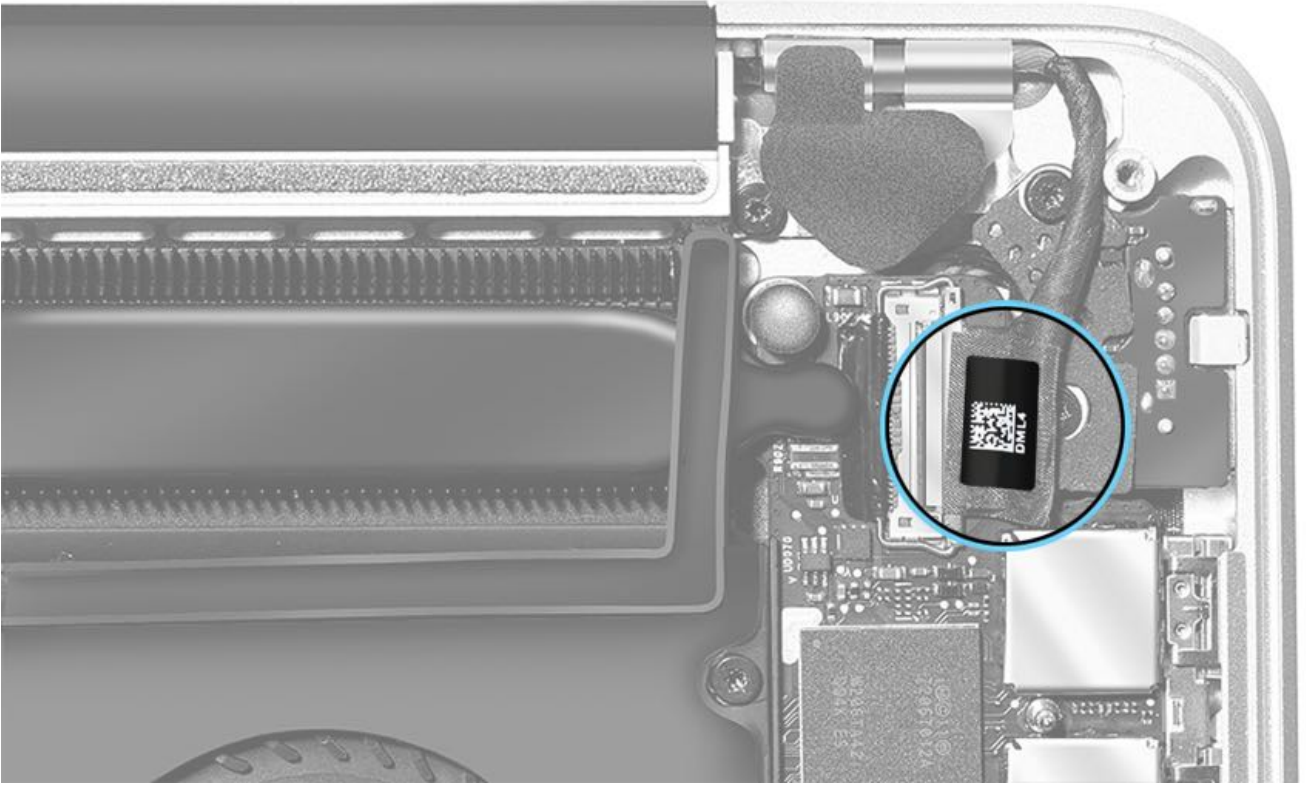
For Mid 2015 only:



## Display Assembly Serial Number

The display's serial number is located on the eDP cable. If it is not visible from the top, disconnect the cable to find it on the other side of the cable.







# Liquid Contact Indicators

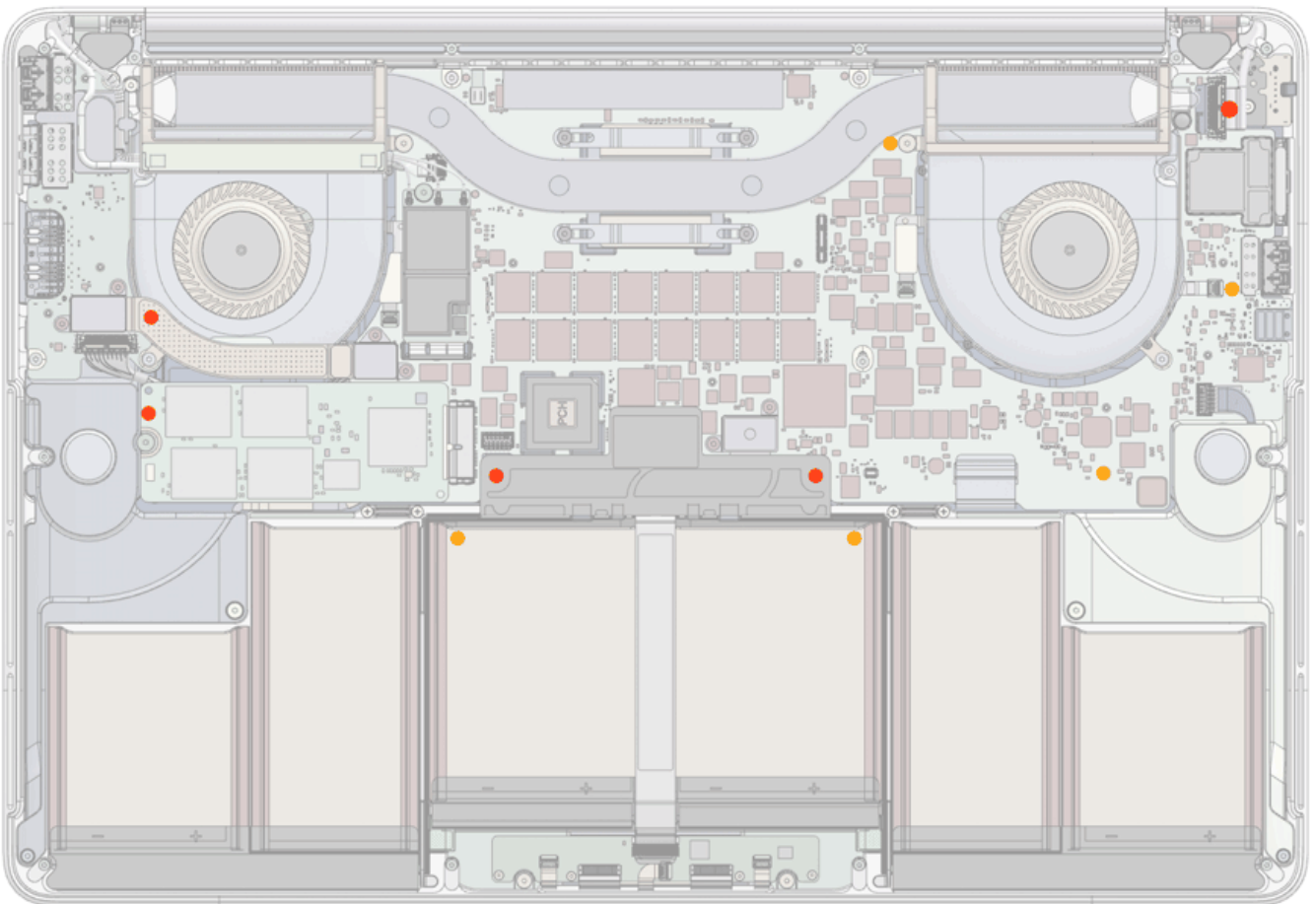
## Liquid Contact Indicators for MacBook Pro (Retina, 15-inch, Mid 2015)

Liquid Contact Indicators (LCIs) have been added to specific locations on current Mac portables to help determine if a computer has been exposed to liquid. Normally represented by small white dots, the LCIs turn red when they have come in contact with liquid, such as an accidental spill.

**Important:** The LCI is a tool that helps technicians identify whether or not a product has been in contact with liquid. Technicians should not rely solely on this tool, but should perform a thorough examination for signs of liquid contact, such as corrosion.

### Key

- **Orange:** LCI is visible with bottom case removed
- **Red:** LCI is hidden (under a module or cable)



# LCD Pixel Anomalies

When displaying a single color over the screen area, the LCD panel might show one or more pixels that are not properly lit.

LCD technology uses rows and columns of addressable points (pixels) that render text and images on the screen. Each pixel has three separate subpixels—red, green, and blue—that allow an image to render in full color. Each subpixel has a corresponding transistor responsible for turning that subpixel on and off.

Depending on the display size, there can be thousands or millions of subpixels on the LCD panel. For example, the LCD panel used in the iMac (27-inch, Late 2013) has a display resolution of 2560 by 1440, which means that there are 3.7 million pixels. Each pixel is made up of a red, a green, and a blue subpixel, resulting in over 11 million individual picture elements on the 27-inch display. Occasionally, a transistor may not work perfectly, which results in the affected subpixel remaining off (dark) or on (bright). With the millions of subpixels on a display, it is possible to have a low number of such transistors on an LCD. In some cases, a small piece of dust or other foreign material may appear to be a pixel anomaly. Apple strives to use the highest quality LCD panels in its products; however, pixel anomalies can occur in a small percentage of panels.

In some cases, pixel anomalies are caused by a piece of foreign material that is trapped somewhere inside the display or on the front surface of the display or glass panel. Foreign material is typically irregular in shape and is usually most noticeable when viewed against a white background.

- For any computer, foreign material on the outer surface of the display or glass panel can be easily removed using a lint-free cloth.
- For iMacs only, foreign material trapped between the glass panel and display should be removed by an Apple Authorized Service Provider or Apple Retail Store.
- For any computer, foreign material trapped inside the display can only be resolved by replacing the entire display assembly.

# Quick Check Procedures

## Resetting the System Management Controller (SMC)

The System Management Controller (SMC) is a chip on the logic board that controls all power functions. If the computer is experiencing any power issue, such as not starting up, not displaying video, sleep issues, or fan noise issues, resetting SMC may resolve it.

**Note for iMacs:** If the power button is pressed while inserting the power cord, the iMac will enter a mode in which the fans run at full speed.

## Resetting Non-Volatile RAM (NVRAM)

NVRAM stores certain system and device settings in a location that macOS can access quickly. Exactly which settings are stored in the computer's NVRAM varies depending on the type of computer as well as the types of devices and drives connected. To reset NVRAM:

1. Shut down the computer.
2. Locate the following keys on the keyboard: Command, Option (Alt), P, and R. You will need to hold these keys down simultaneously in Step 4.
3. Press power button.
4. Immediately press and hold Command-Option-P-R keys.  
**Important:** You must press this key combination before the gray screen appears.
5. Hold down keys until computer restarts, and you hear startup chime a second time.  
**Note:** For MacBook Pro (Late 2016 and 2017) and MacBook (Retina, 12-inch, 2017), hold down keys for at least 20 seconds. There is no startup chime.
6. Release keys.

**Note:** After resetting NVRAM, you might need to reconfigure settings for speaker volume, screen resolution, startup disk selection, and time zone information.

## Starting Up in Safe Mode

Safe Mode (sometimes called Safe Boot) is a way to start up a Mac so that it performs certain checks and prevents some software from automatically loading or opening. These changes can help resolve or isolate certain issues on the startup disk.

Follow these steps to start up into Safe Mode:

1. Be sure the computer is shut down.
2. Press the power button.
3. Press and hold the Shift key.  
**Note:** The Shift key should be pressed as soon as possible after the power button is pressed.
4. Release the Shift key when you see the Apple logo appear on the screen. After the Apple logo appears, it may take longer than usual to reach the login screen. This is because the computer is performing a directory check as part of Safe Mode.
5. To leave Safe Mode, restart the computer without pressing any keys during startup.

# Recovering a Lost Firmware Password

Only Apple Retail Stores or Apple Authorized Service Providers can unlock the following Mac models when protected by a firmware password:

- iMac (Mid 2011 and later)
- MacBook (Retina, 12-inch, Early 2015 and later)
- MacBook Air (Late 2010 and later)
- MacBook Pro (Early 2011 and later)
- Mac mini (Mid 2011 and later)
- Mac Pro (Late 2013)

# Sleep Status Tips

The following portable Mac models do not have a sleep LED:

- MacBook Air (Late 2010 and later)
- MacBook Pro (Retina, Mid 2012 to Mid 2015)

To troubleshoot without a sleep LED:

- Connect a USB device that has a power-on or activity LED. As power is restored to the USB and the system wakes from sleep, the LED lights up.
- Press Caps Lock key multiple times to wake the computer from sleep.
- Open display and press an alphanumeric key to wake the computer from sleep.
- A computer that has been asleep for an extended period can consume the remaining charge of the battery. Restore power to the computer with known-good power adapter, and check that the MagSafe indicator light shows an in-progress battery charge. The computer will boot from a hibernation file and start up from where it left off.
- Resetting SMC instantly shuts down the computer, with some side effects:
  - If the computer is in sleep mode, it will reboot from a hibernation file.
  - If the computer is booted to OS X or macOS during the SMC reset, data from open applications can be lost.
  - If the computer is already shut down, there will be no side effects.

**Note:** Look for the MagSafe indicator light to momentarily switch from off to green as SMC is reset and re-establishes communication with power adapter, then change from green to orange if the battery needs a charge.

# Diagnostic Software

## Apple Service Toolkit 2 (AST 2)

AST 2 is a cloud-based diagnostic system to help technicians triage and verify repairs for iOS devices and Mac computers released in June 2014 and later, except for MacBook Pro (Retina, Mid 2014). With AST 2, technicians initiate diagnostics wirelessly on a user's device using a Diagnostic Console (a web application on a Mac or iPad). Technicians are also able to view diagnostic results on the Diagnostic Console.

## Apple Diagnostics

Apple Diagnostics is a customer-facing software tool that is built-in to all Mac computers released in June 2013 and later.

# Thermal and Electrical Sensors

## Thermal and Electrical Sensors for MacBook Pro (Retina, 15-inch, Mid 2015)

### Thermal Sensors

SMC Name	Location	Diagnostic Name	Repair Suggestion
Ta0P	Logic board, near eDP connector	Airflow Proximity	Excessive air intake area temperature, or the logic board sensor near the air intake is damaged or disconnected from the SMC.
TB0T	Battery	Battery TS Max	Excessive internal battery temperature, damaged interposer board, or open/damaged BMU or logic board contacts.
TB1T	Battery	Battery TS1	Excessive internal battery temperature, damaged interposer board, or open/damaged BMU or logic board contacts.
TB2T	Battery	Battery TS2	Excessive internal battery temperature, damaged interposer board, or open/damaged BMU or logic board contacts.
TC0P	Logic board	CPU Proximity	Excessive CPU temperature, or the logic board sensor near the CPU is damaged or disconnected from the SMC.
TC1C	Logic board, CPU	CPU Core 0 Temp	Excessive CPU temperature, or the CPU sensor is damaged.
TC2C	Logic board, CPU	CPU Core 1 Temp	Excessive CPU temperature, or the CPU sensor is damaged.
TC3C	Logic board, CPU	CPU Core 2 Temp	Excessive CPU temperature, or the CPU sensor is damaged.
TC4C	Logic board, CPU	CPU Core 3 Temp	Excessive CPU temperature, or the CPU sensor is damaged.
TCGC	Logic board, GPU	CPU GFX Core Temp	Excessive GPU temperature, or the GPU sensor is damaged.
TCSA	Logic board, CPU	CPU SA Core Temp	Excessive logic board temperature, or the proximity sensor on the logic board is damaged.
TCXC	Logic board, CPU	CPU PECL Die Temp	Excessive logic board temperature, or the proximity sensor on the logic board is damaged.
TH0A	Flash storage	SSD Temp A	Excessive flash storage temperature, or the flash storage card is damaged or disconnected from the logic board.
TH0B	Flash storage	SSD Temp B	Excessive flash storage temperature, or the flash storage card is damaged or disconnected from the logic board.
Th1H	Logic board, near right fin stack	Right Fin Stack	Excessive heat sink fin stack temperature, or the fin stack proximity sensor on logic board is damaged. Verify that the fan is operational for proper cooling.
Th2H	Logic board, near left fin stack	Left Fin Stack	Excessive heat sink fin stack temperature, or the fin stack proximity sensor on the logic board is damaged. Verify that the fan is operational for proper cooling.
TM0P	Logic board, near memory	DDR3 Proximity	Excessive logic board temperature near memory, or the proximity sensor on the logic board is damaged.
TP0P	Logic board, platform controller hub (PCH)	PCH Proximity	Excessive PCH temperature, or the logic board sensor near the PCH is damaged or disconnected from the SMC.
TPCD	Logic board, CPU	PCH PECL Die Temp	Excessive Intel PCH temperature, or the PCH sensor is damaged.
Ts0P	Trackpad	Palm Rest	Excessive internal enclosure temperature, or the trackpad is damaged/disconnected from the logic board.
Ts1P	On trackpad actuator	Palm Rest Actuator	Excessive internal enclosure temperature, or the trackpad is damaged/disconnected from the logic board.
TW0P	Logic board, near wireless card	AirPort Proximity	Excessive wireless card temperature, or the wireless card is damaged or disconnected from the logic board.

### Electrical Sensors

SMC Name	Location	Diagnostic Name	Repair Suggestion
ALSL	Display assembly	Light Detection near FaceTime HD Camera	Out-of-range light detection or open signal from the display assembly connection (camera cable) to the logic board. Possible interaction with trackpad temperature sensor (TS0P). Disconnect trackpad and retest the ambient light sensor (ALS) to logic board connections and the communication with the SMC. It is possible, but unlikely, that the logic board motion sensor Accelerometer (M0_X) can interfere with the ALS. If the logic board accelerometer is also failing, disconnect the camera cable to remove ALS and test to see if the accelerometer still fails. Substitute a known-good logic board or display assembly to determine whether the fault is with the logic board or the display.
IC0C	Logic board	Current: CPU Core	Out-of-range CPU current found, or open signal to SMC.
IC0R	Logic board	Current: CPU High (CPU, VCCIO)	Out-of-range CPU current found, or open signal to SMC.
IC1C	Logic board	Current: PCH Core 1.05V	Out-of-range CPU current found, or open signal to SMC.
IC2C	Logic board	Current: CPU Core (IMON)	Out-of-range CPU current found, or open signal to SMC.
ID0R	Logic board	Current: DC-In, MagSafe	Out-of-range DC-IN power current, defective MagSafe board or stuck pins, or open signal to SMC. Connect the correct model MagSafe adapter for battery charging.
IHDC	Logic board	Current: SSD	Excessive flash storage current found, or open signal to SMC.
IHSC	Logic board	Current: Thunderbolt TBT (Default)	Out-of-range Thunderbolt controller current found, or open signal to SMC. Disconnect Thunderbolt device(s) to determine the logic board fault and/or substitute the Thunderbolt device and cable to isolate the fault.
IM0C	Logic board	Current: LPDDR 1.2V (CPU & Mem)	Out-of-range memory current found, or open signal to SMC.
IO3R	Logic board	Current: Other 3.3V High	Out-of-range logic board current found, or open signal to SMC.
IO5R	Logic board	Current: Other 5V High	Out-of-range logic board current found, or open signal to SMC.
IPBR	Logic board	Current: Battery (BMON)	Out-of-range battery current found, or open signal to SMC. Verify that the BMU interconnect screw is installed.
VC0C	Logic board	Voltage: logic board	Out-of-range voltage to CPU found, or open signal to SMC.
VD0R	Logic board	Voltage: DC In (AMON)	Out-of-range voltage from MagSafe 2 found, or open signal to SMC. Use the correct MagSafe 2 AC power adapter and verify that the connector pins are clean and make a good electrical connection.
VP0R	Logic board	Voltage: P-Bus	Out-of-range voltage from the battery or charge circuitry found on the logic board, or open signal to SMC. Use the correct MagSafe 2 AC power adapter and verify that the connector pins are clean and make a good electrical connection. Recharge the battery.



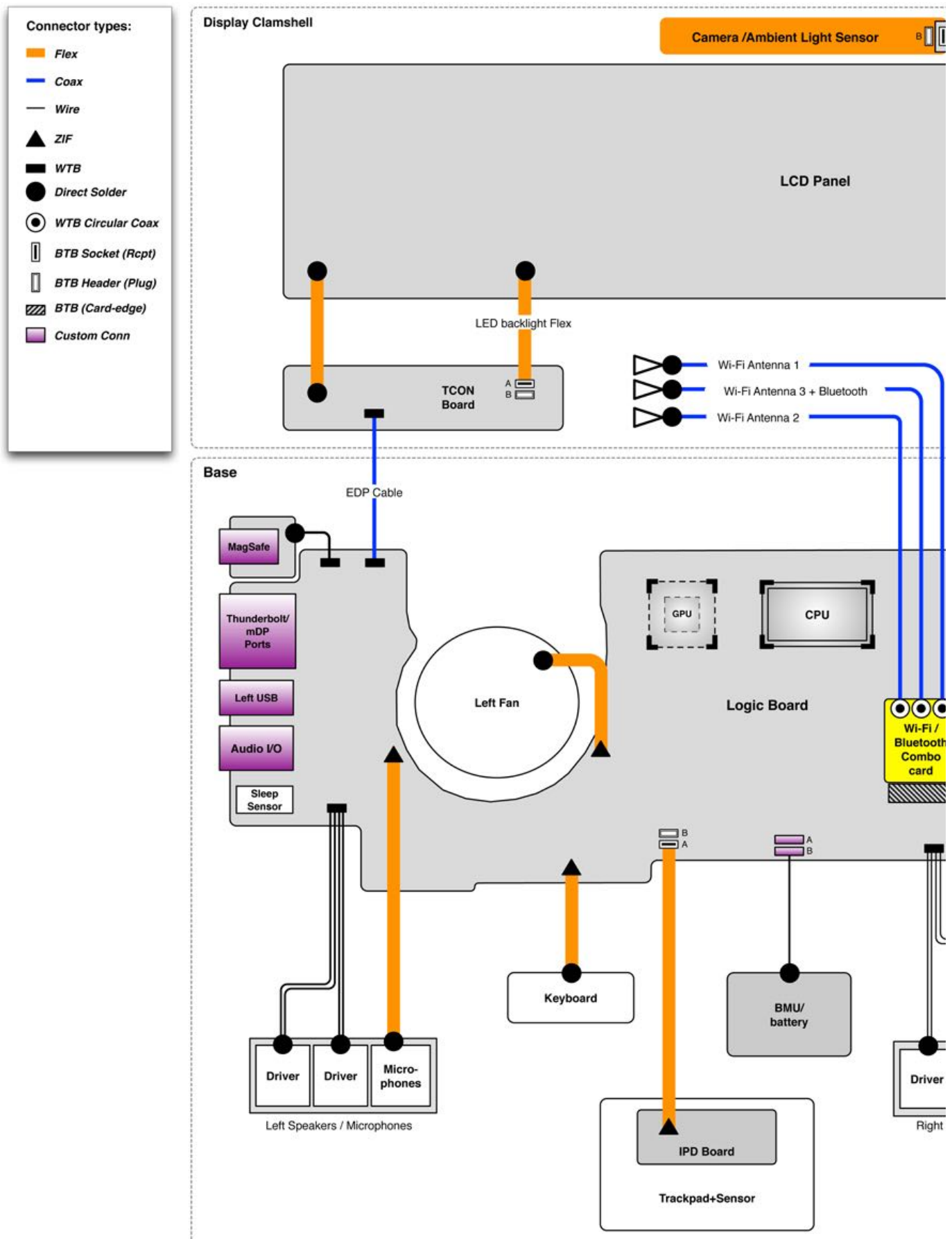
## Temperature Concerns

The normal operating temperature of this computer is well within national and international safety standards. Nevertheless, users may be concerned about generated heat. To prevent an unnecessary repair, compare a user's computer to a similar running model under similar load, if available at the repair site.

# Interconnect Diagram

## Interconnect Diagram for MacBook Pro (Retina, 15-inch, Late 2013, Mid 2014, and Mid 2015)

Refer to this diagram to see how modules are interconnected.

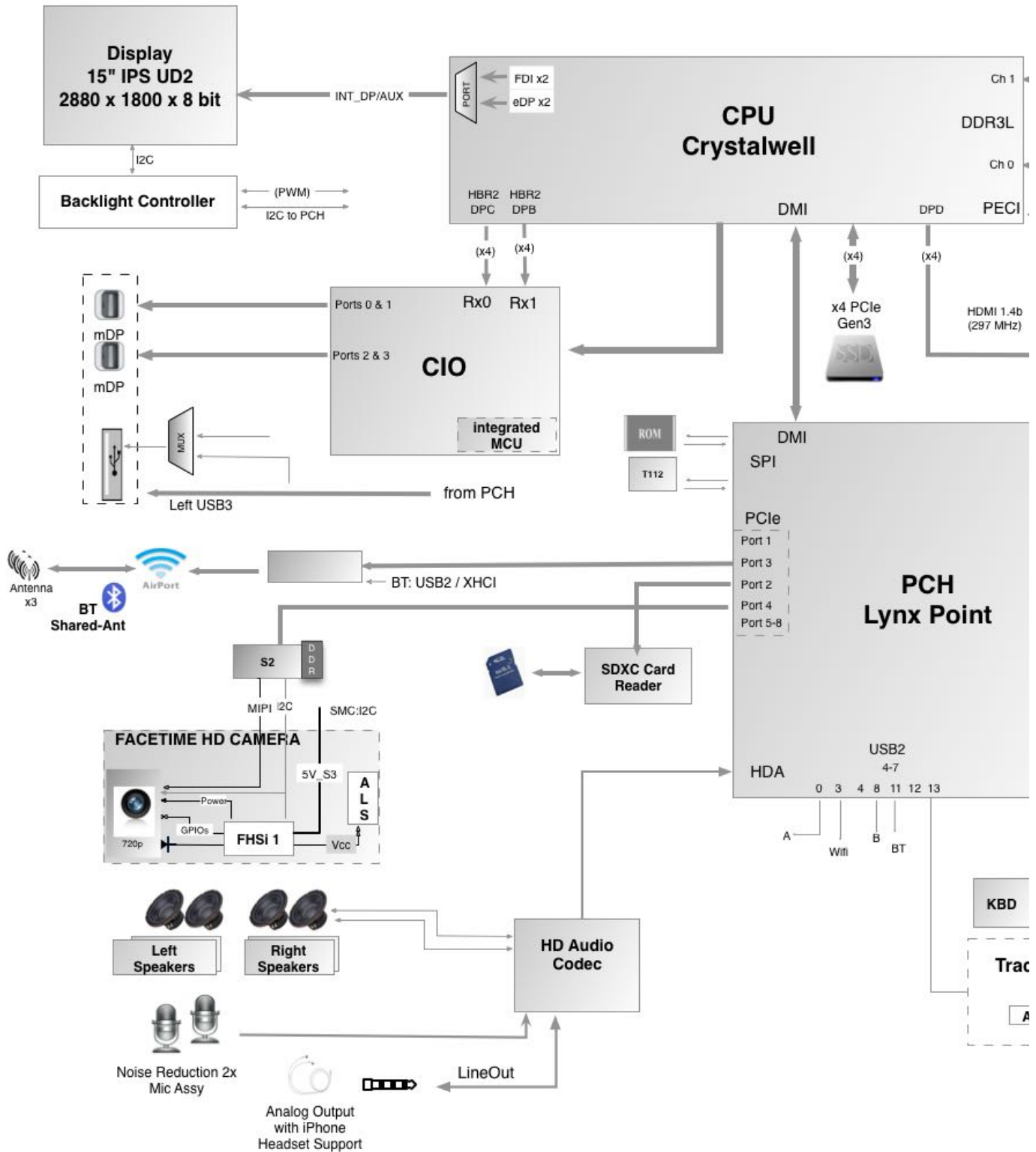


# Block Diagram

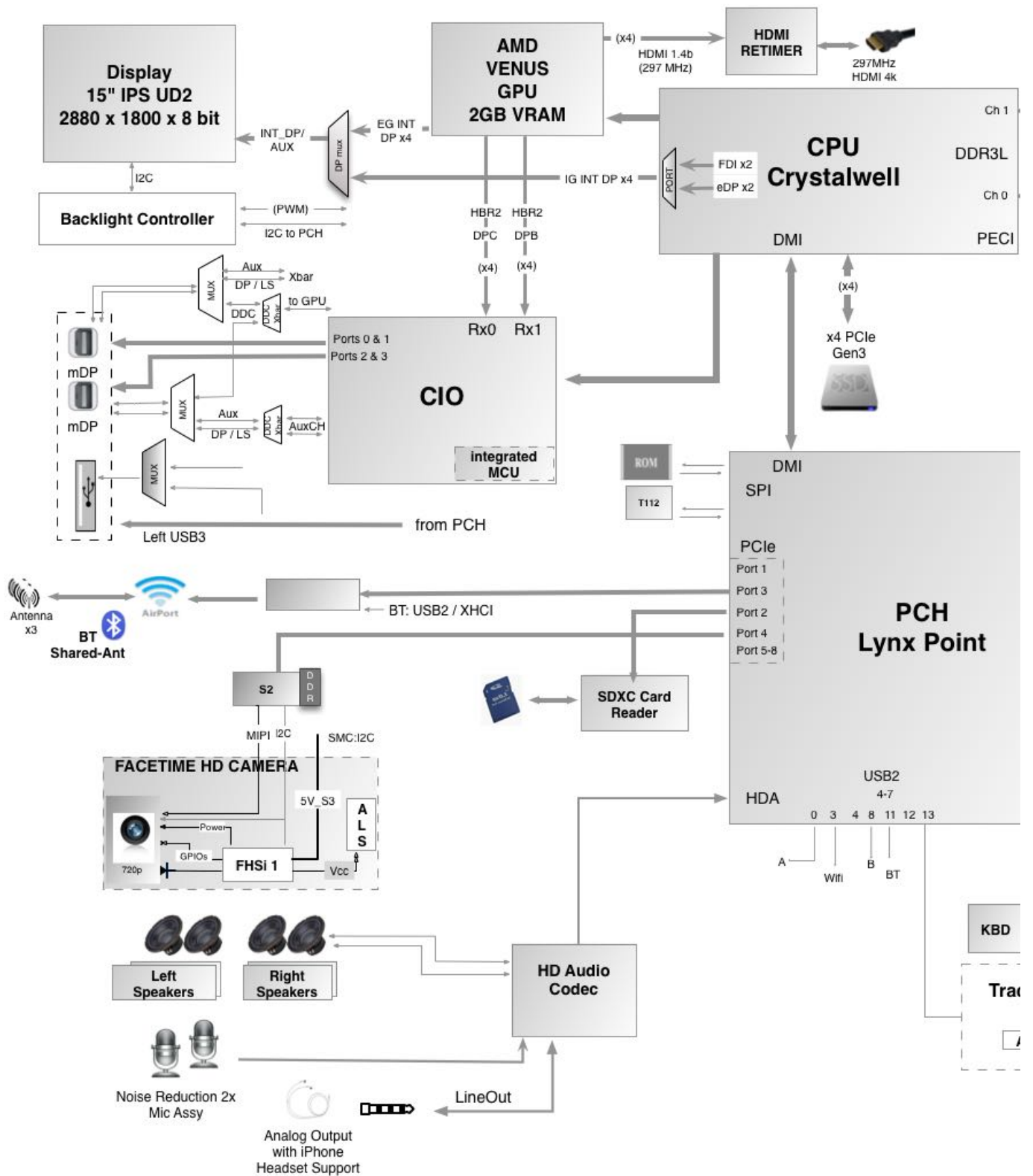
## Block Diagram

Refer to this diagram to see how modules are interrelated.

### MacBook Pro (Retina, 15-inch, Mid 2015) with Integrated Graphics



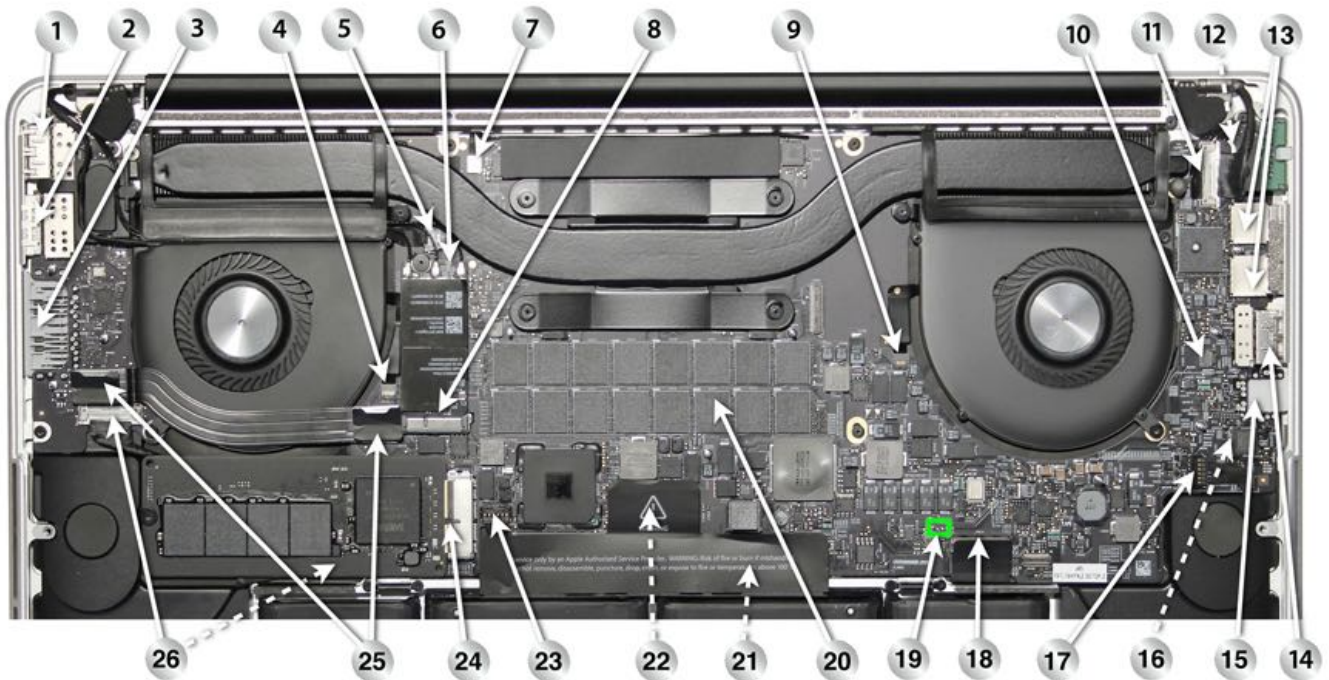
### MacBook Pro (Retina, 15-inch, Mid 2015) with Discrete Graphics Processor Unit (GPU)



# Functional Overview

## Functional Overview for MacBook Pro (Retina, 15-inch, Mid 2015)

Refer to this diagram for symptoms related to logic board connectors.



### 1 = Right USB port

- USB device not found
- Controller not recognized
- USB driver issues
- USB power issues

### 2 = HDMI video

- HDMI controller not recognized
- No HDMI video
- No HDMI audio
- No power from the HDMI port

### 3 = SD card slot

- SD card not recognized
- SD card insertion issues

### 4 = Right fan

- Fan not running
- Noisy fan perception
- Intermittent shutdown

### 5 = FaceTime HD camera & ambient light sensor (part of display assembly)

- No video, or blurred or monochrome video
- Display does not dim in low light conditions
- Keyboard backlight cannot be turned on

### 6 = Wi-Fi + Bluetooth antenna connectors

- No/poor Wi-Fi reception
- Drops Wi-Fi connection
- Does not pair with Bluetooth devices
- Drops Bluetooth connection

### 7 = Keyboard backlight flex cable (part of top case)

- No keyboard backlight

#### **8 = Wireless card**

- Wi-Fi service cannot be turned on
- Bluetooth service cannot be turned on

#### **9 = Left fan**

- Fan not running
- Noisy fan perception
- Intermittent shutdown

#### **10 = Microphone**

- No internal audio input (with Internal Microphone selected in Sound Input Preferences)

#### **11 = LCD/backlight**

- No video on LCD
- No display backlight
- Open backlight fuse

#### **12 = MagSafe 2 (under the logic board)**

- No power LED
- No battery charge

#### **13 = Thunderbolt ports (2)**

- Thunderbolt device not found
- Thunderbolt controller not recognized
- Thunderbolt driver issue
- Thunderbolt power issues

#### **14 = Left USB port**

- USB device not found
- Controller not recognized
- USB driver issues
- USB power issues

#### **15 = Audio port (soldered on the logic board)**

- No external analog audio/digital optical output
- No headset controls or mic input

#### **16 = Sleep sensor (on the bottom side of the logic board)**

- Computer does not sleep when display is closed
- No video to internal display, but video to external display if one is connected (sensor stuck)

#### **17 = Left speaker**

- No/distorted audio from left speaker

#### **18 = Keyboard flex cable**

- Computer will not turn on from keyboard
- Nonresponsive keys

#### **19 = Power-on pads**

- When shorted with a flat-blade screwdriver, these pads on the logic board will turn on the computer if the power button cannot

#### **20 = Onboard memory (soldered on logic board)**

- Three beep tones on startup
- Freeze or kernel panic
- Horizontal video lines

**21 = IPD flex cable**

- No Multi-Touch or cursor movement from the built-in trackpad
- No click action from the built-in trackpad
- Trackpad thermal sensor input is missing - fan is running at full speed

**22 = Battery**

- Not running when on battery only
- Not charging (verify with the correct model of power adapter)
- X symbol for battery in menu bar
- When the battery is removed - extended time before boot chime and fan running at full speed

**23 = Right speaker**

- No audio or distorted audio from the right speaker

**24 = Flash storage card**

- Flash storage device is not visible in System Information
- OS boot failure from internal flash storage

**25 = I/O flex cable (between the I/O board and the logic board)**

- Right USB port issues
- No right USB power
- No HDMI video
- No SD card slot function

**26 = I/O coaxial cable (between the I/O board and the logic board)**

- Right USB port issues
- No right USB power
- No HDMI video
- No SD card slot function

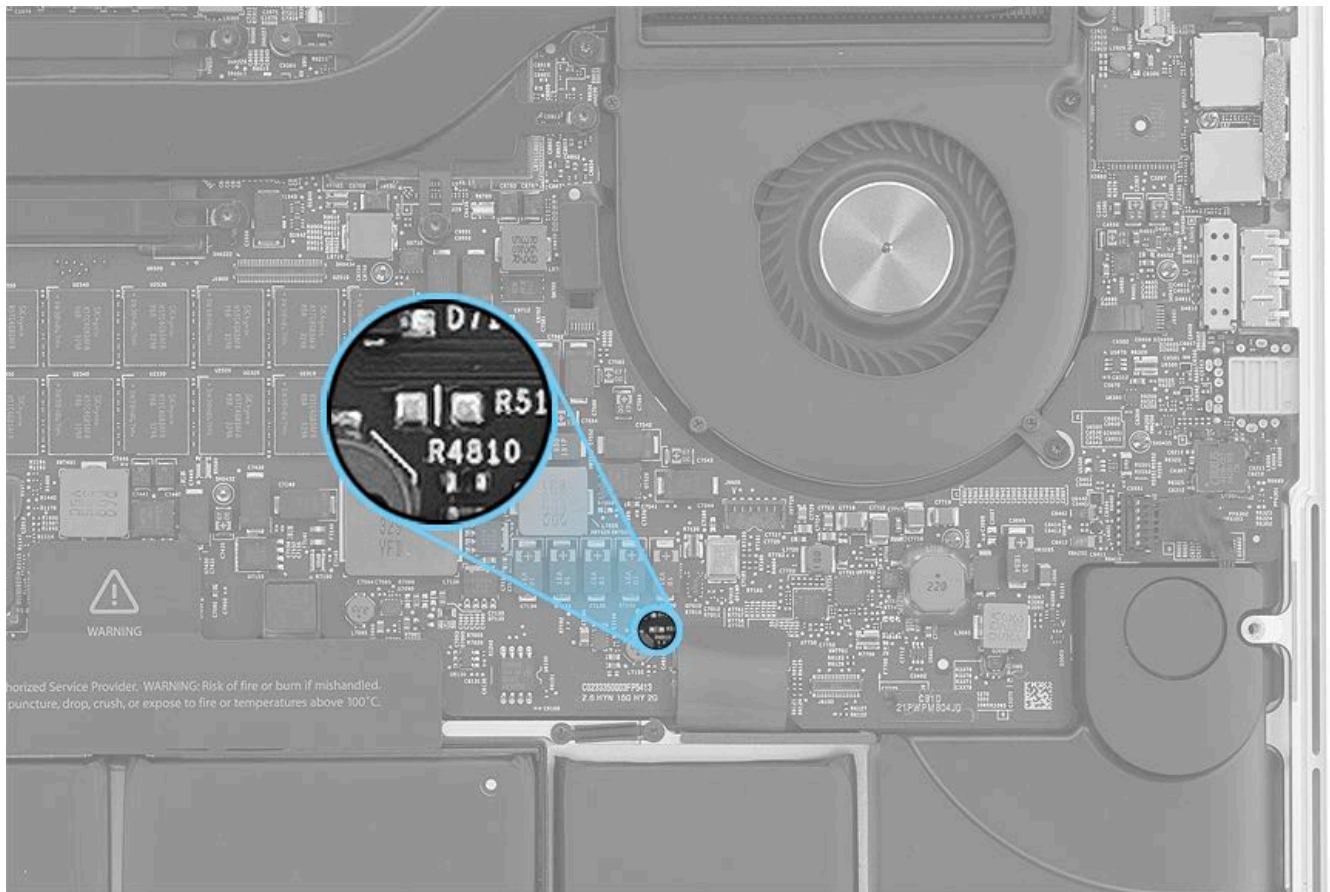


# Logic Board Power-On Pads

## Logic Board Power-On Pads for MacBook Pro (Retina, 15-inch, Late 2013, Mid 2014, and Mid 2015)

On the logic board, there are two pads that can be shorted to turn on the computer. The location of these pads is shown below. The power-on pads are shiny, silver, square, and larger than the other (mostly round) silver pads nearby.

**Important:** Only short these two pads and no other pads, or you may damage the logic board. The tip of a T8 or T10 Torx screwdriver is about the right size to touch these two pads without touching other nearby components.





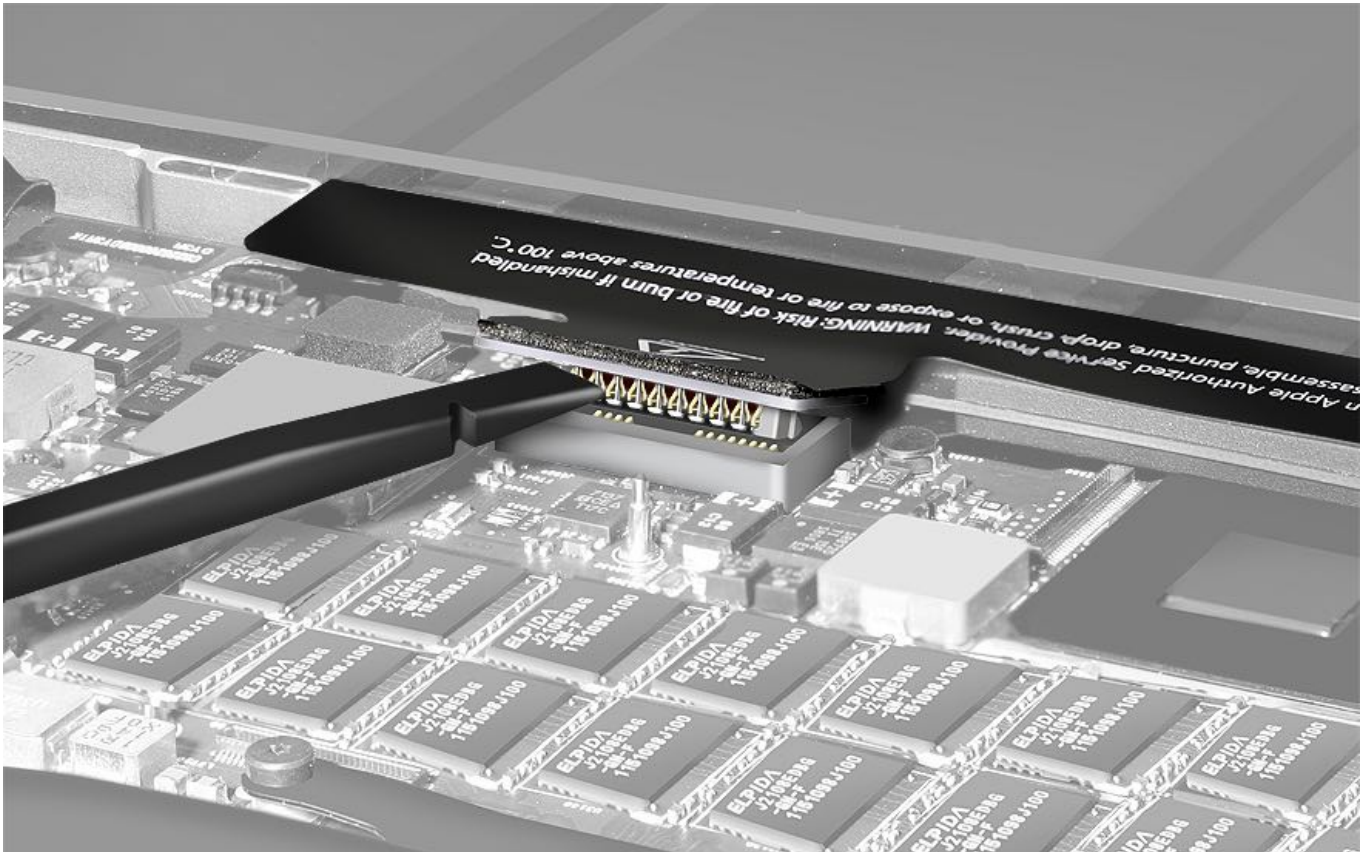
# Connector Types on Logic Board

## Connector Types on Logic Board

On the logic board are seven types of connectors, each requiring special handling. Make sure you read these tips before disconnecting and installing the connectors.

### Battery Connector

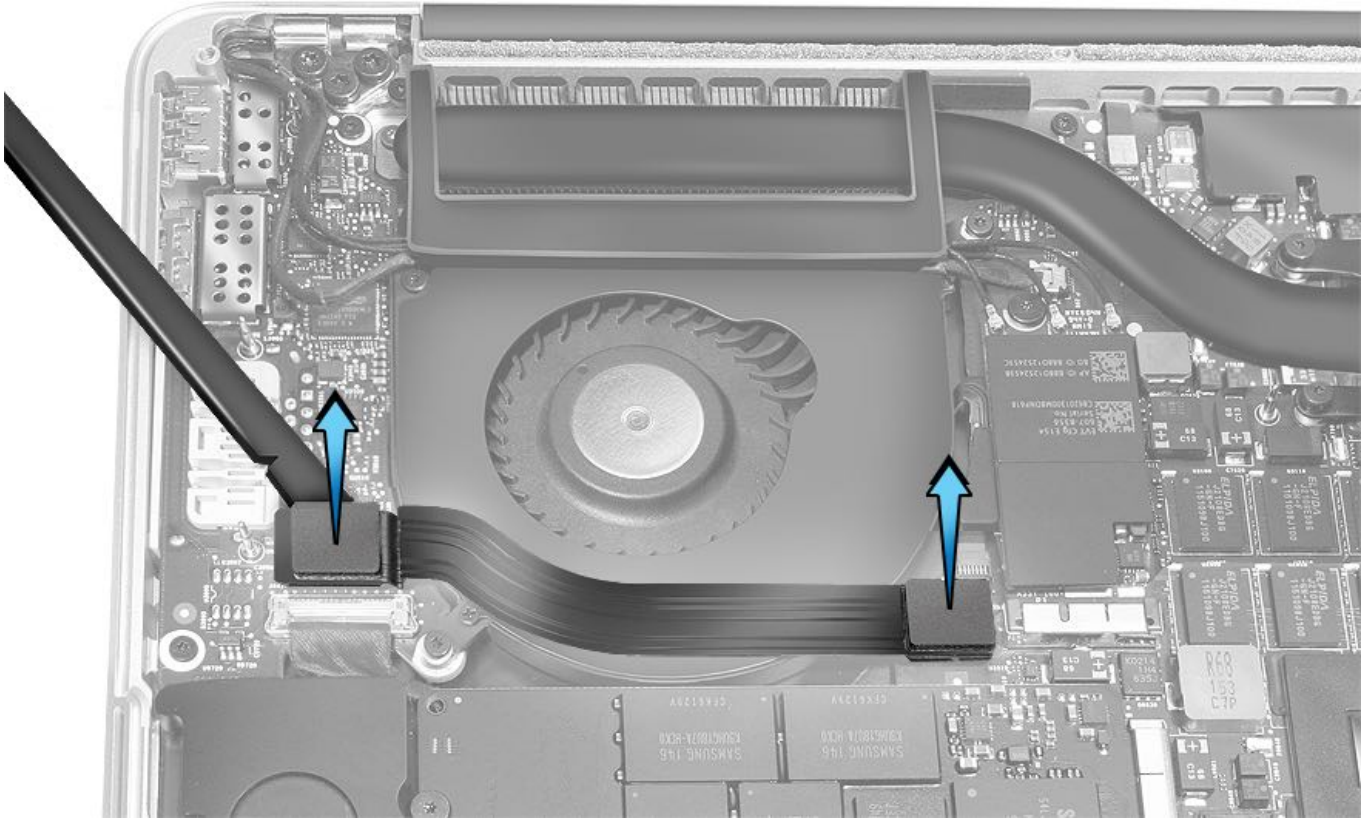
- Use the flat end of a black stick to pry up the connector.
- To reconnect the cable, align it with the logic board connector and press straight down.



### Low-Profile Solid Platform Flex

Example:

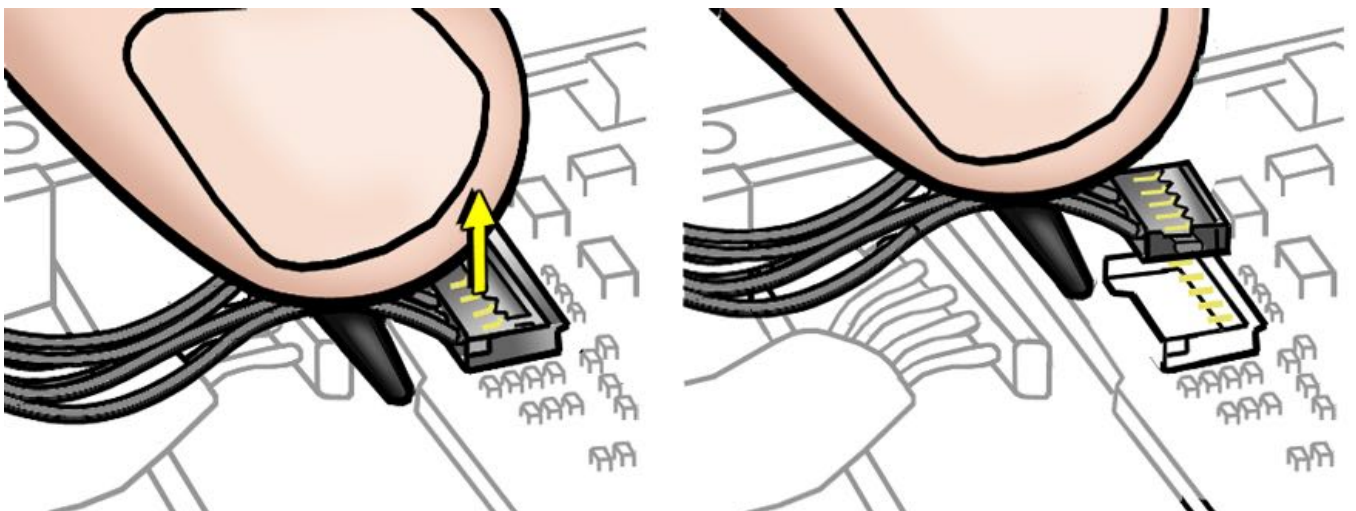
- Remove and insert the I/O flex cable connector vertically. The connectors are susceptible to bent pins if they are not inserted carefully and correctly.
- To reconnect the cable, keep the connector level to the board and press down evenly.
  - I/O flex cable
  - Trackpad cable
  - Audio board cable
- For Mid 2015: The I/O flex cable and trackpad cable have metal brackets that are held in place with Torx T5 screws. These must be removed before disconnecting and must be reinstalled when reconnecting the I/O flex cable and trackpad cable.



### Vertical Insertion (JST)

Example:

- Use a black stick under the cable to remove.
- Keep the connector level to the board when disconnecting and reconnecting.
- Press evenly when reconnecting or connector can be tipped up and not fully seated.
  - Right speaker
  - Left speaker



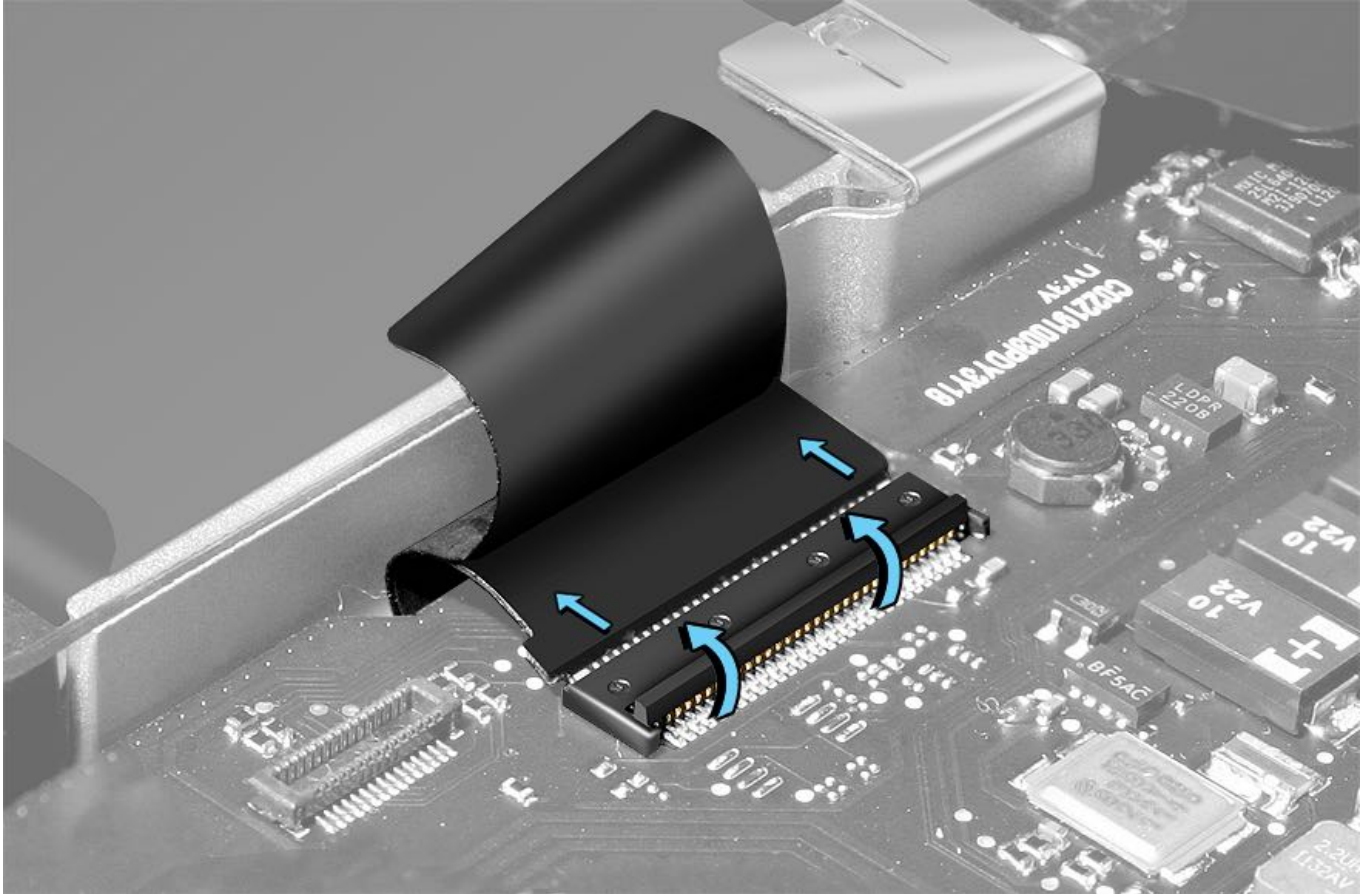
### Locking Lever

Example:

- Flip the lever up to a 90-degree angle for cable removal.
- Slide the cable into the receptacle on the same horizontal plane as the logic board.
- Lock down the lever after inserting the cable.

- Close the lever when handling or shipping a logic board module, whether it is a known-good or a known-bad board.
  - Fans
  - Keyboard power-on button
  - Microphone

**Caution:** The locking levers on the logic board are fragile. To protect the levers during handling or shipment of the logic board, **close the levers** after the cables are removed. Once the logic board is installed in the top case and the cables are connected, be sure to lock down the levers again.

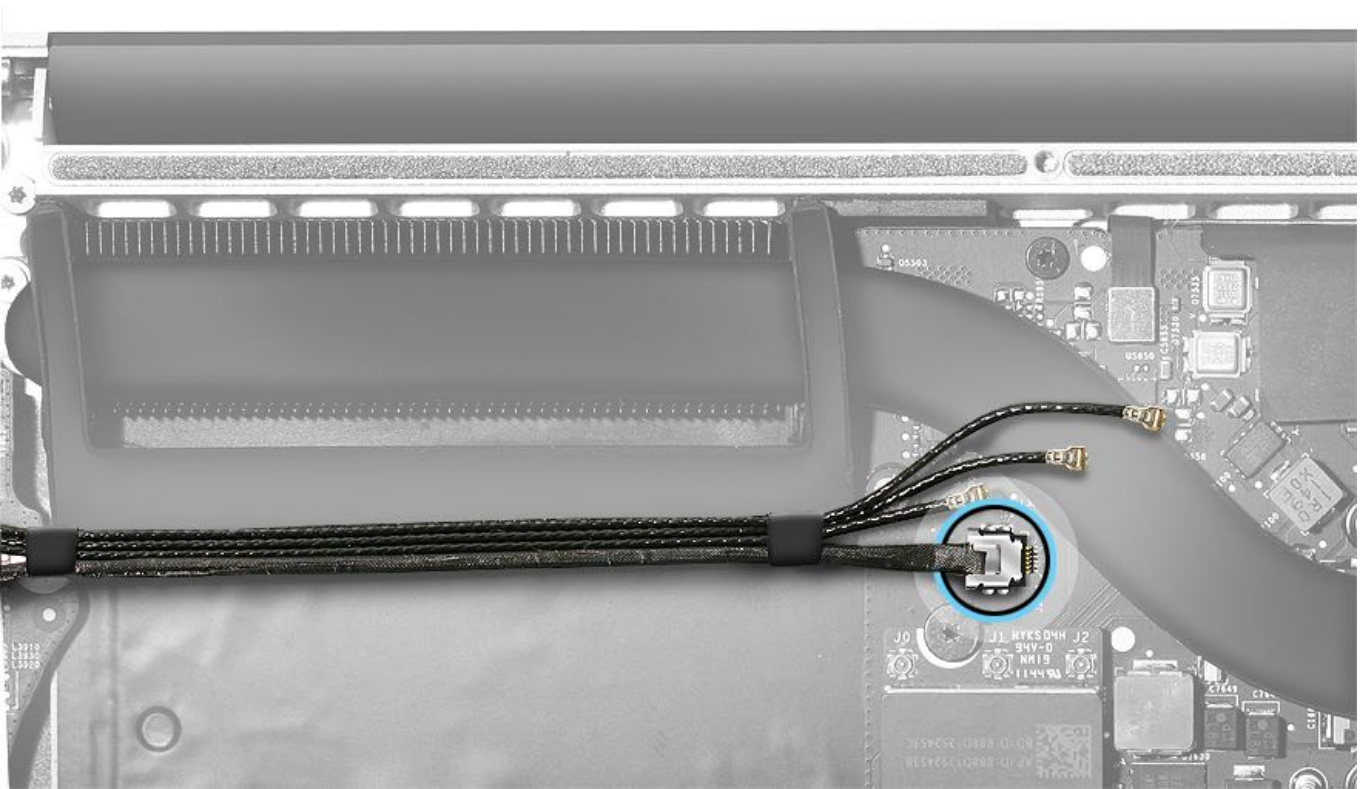


#### Thin, Multi-Pin Horizontal Insert: No Locking Bar

Example:

- Use a black stick on alternating sides to evenly disconnect the cable.
- Slide the connector into the receptacle on the same horizontal plane as the board.
  - Camera cable





### Thin Multi-Pin Horizontal Insert: Lock Bar

Example:

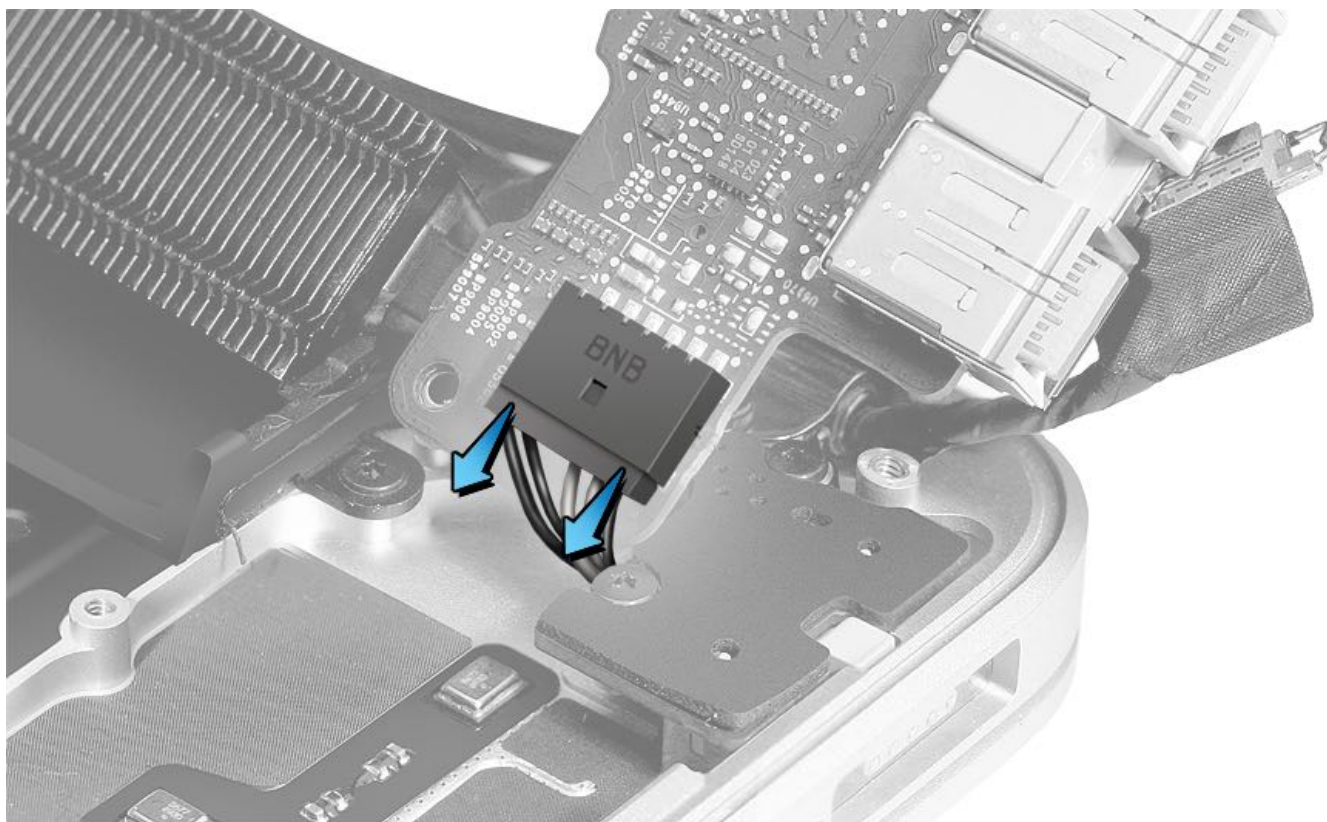
- Flip the lock bar up before disconnecting the cable, but do not use the bar as a handle when disconnecting.
- After reinstalling the cable, flip the lock bar over the leads to secure the cable in place.
  - Display cable (eDP)
  - I/O coax cable



**Horizontal-Install**

Example:

- Pull the connector, not the cable, to remove.
- Slide the connector into the receptacle on the same horizontal plane as the board.
  - MagSafe 2 cable



# Tools

## Tools for MacBook Pro (Retina, 15-inch, Mid 2012, Early 2013, Late 2013, Mid 2014, Mid 2015)

**Caution:** To prevent scratches or other cosmetic damage to the computer housing, use a soft cloth as a protective layer when removing and installing the external screws.

The following tools are required to service the computer:

- Clean, soft, lint-free cloth
- ESD-safe workstation, including an ESD mat and wrist or heel strap
- ESD bags (for storing ESD-sensitive parts while removed from unit)
- Battery cover (923-0089) for MacBook Pro (Retina, 15-inch, Mid 2012 and Early 2013)
- Battery cover (923-0706) for MacBook Pro (Retina, 15-inch, Late 2013, Mid 2014, and Mid 2015)
- Pentalobe screwdriver (923-0731)
- Torx T5 screwdriver (magnetized)
- Torx T8 screwdriver (magnetized)
- Black stick (nylon probe, 922-5065) or other nonconductive nylon or plastic flat-blade tool
- ESD-safe plastic or nylon tweezers for wireless card cables
- Thermal grease syringe (included with heat sink and logic board)
- Isopropyl alcohol (IPA) wipe (included with heat sink and logic board)
- Magnifying glass (for reading serial number etched on bottom case)
- Foam wedge service fixture

## Electrostatic Discharge (ESD) Precautions

Proper ESD precautions must always be used when servicing this product. Make sure you are working on a properly grounded ESD-safe mat and are wearing a properly connected ESD-safe wrist strap.

# First Steps Overview

## First Steps Overview for MacBook Pro (Retina, 15-inch, Mid 2015)

The following chart shows the parts that must be removed before a take-apart procedure can be performed on MacBook Pro (Retina, 15-inch, Mid 2015). Procedures are listed in the left column. Parts that must first be removed are indicated with a black box in the row for each procedure. A white box indicates to attach the battery cover and disconnect the battery.

### FIRST STEPS

#### PARTS

	Bottom Case	Battery Cover and Disconnect	Trackpad Flex Cable	Flash Storage	Wireless Card	I/O Flex Cable	Right Fan	Left Fan	I/O Board	Logic Board	Heat Sink	I/O Coax Cable	Right and Left Speakers	MagSafe 2 Board	Right Fan Duct	Left Fan Duct	Display Assembly with End Caps	Top Case with Battery
Bottom Case	■																	
Battery Cover and Disconnect	■	□																
Trackpad Flex Cable	■		■															
Flash Storage	■	□		■														
Wireless Card	■	□			■													
I/O Flex Cable	■	□				■												
Right Fan	■	□				■	■											
Left Fan	■	□						■										
I/O Board	■	□				■	■		■									
Logic Board	■	□	■	■	■	■	■	■	■	■	■	■						
Heat Sink	■	□									■							
I/O Coax Cable	■	□		■		■	■		■	■		■						
Right and Left Speakers	■	□		■	■	■	■	■	■	■			■					
MagSafe 2 Board	■	□		■		■	■	■	■	■				■				
Right Fan Duct	■	□		■		■	■	■	■	■					■			
Left Fan Duct	■	□		■		■	■	■	■	■						■		
Display Assembly with End Caps	■	□															■	
Top Case with Battery	■	□	■	■		■	■	■	■	■			■	■			■	■

#### Notes

- Top case includes: battery, keyboard, trackpad, microphone, and fan ducts. Battery, keyboard, and trackpad are not separate, replaceable parts.
- If you are installing a replacement logic board, transfer these parts to the replacement board: wireless card, heat sink, and I/O coax cable.
- Right and left speakers are paired; if you are installing a replacement speaker, you must replace both speakers.

# Take Apart Procedure Notes

## Reassembly Steps

When no replacement steps are listed, replace parts in exact reverse order of Removal procedure.

## Note About Images in This Guide

In some cases a pre-production model may have been used to document the procedures in this guide. Although there may be small differences in appearance between the image pictured and the computer you are servicing, the procedures are the same unless noted.

## Screw Sizes

All screw sizes shown are approximate and represent the total length of the screw.



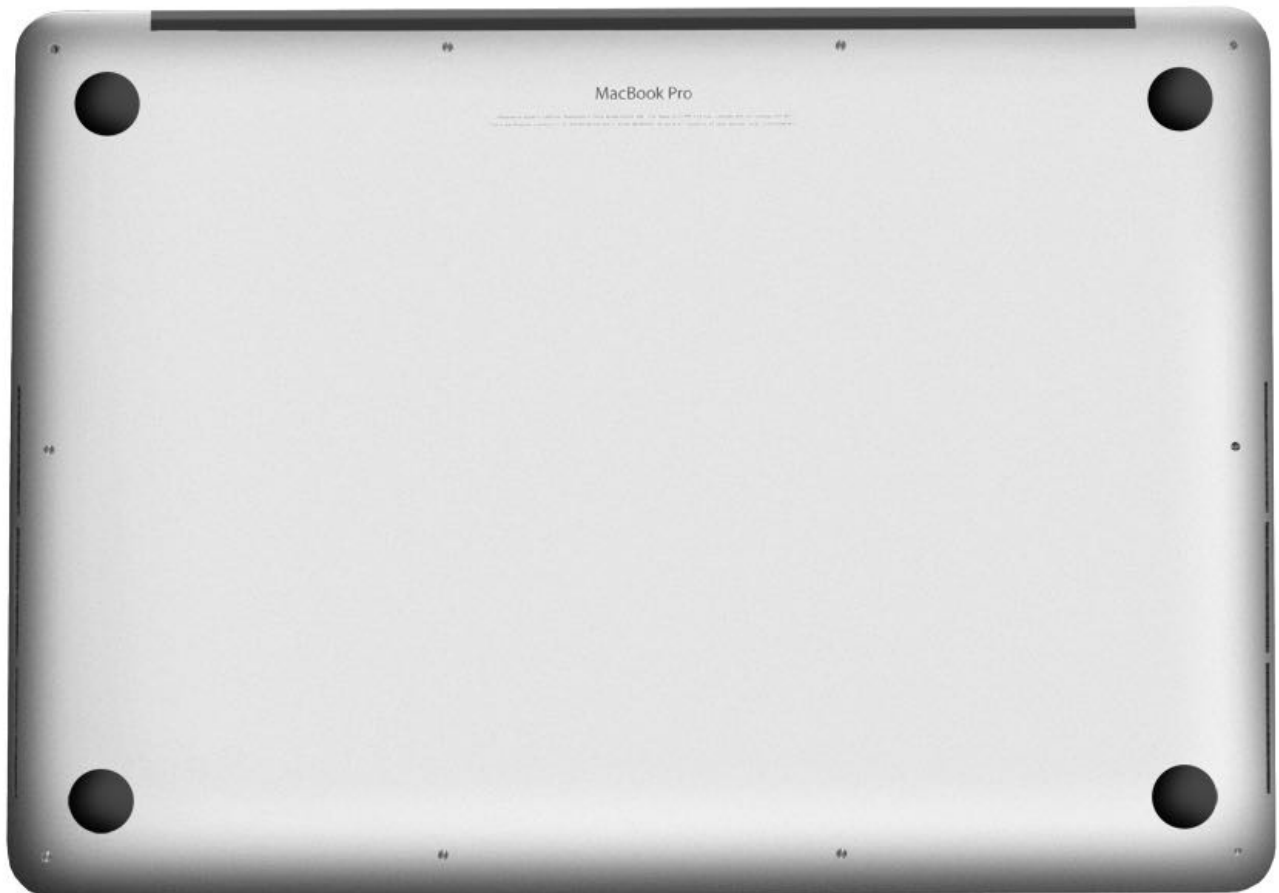


# Bottom Case

## First Steps

**Important:** This procedure should only be performed by Apple-certified technicians.

- Shut down the computer.
- Unplug all cables.
- Put on an ESD strap.
- Place the computer face down on a clean, flat surface.



## Tools

- ESD wrist strap
- Clean, soft, lint-free cloth
- Pentalobe screwdriver
- Black stick



## Steps For Removal

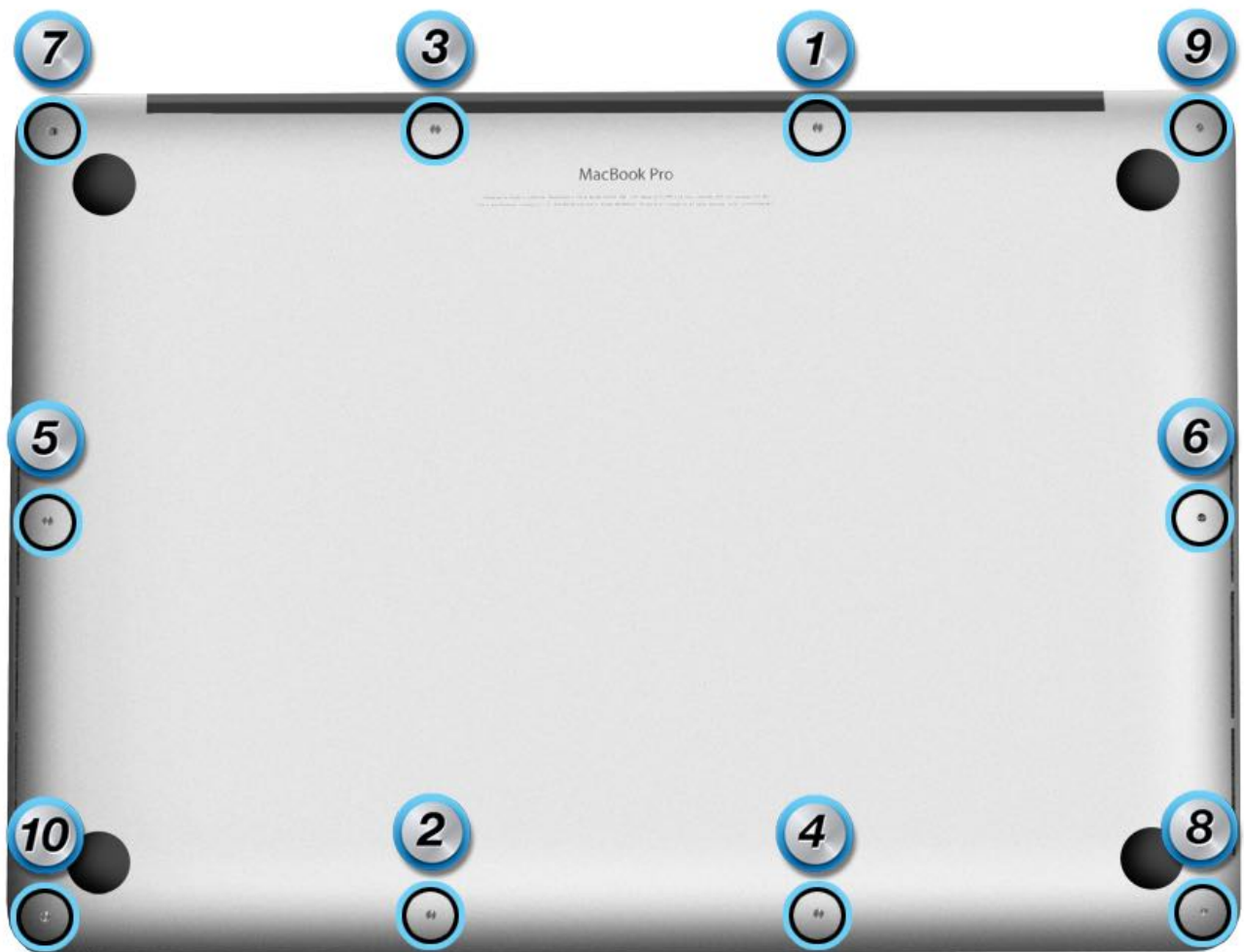
**Caution:** To prevent scratches, use a protective cloth when working with metal tools.

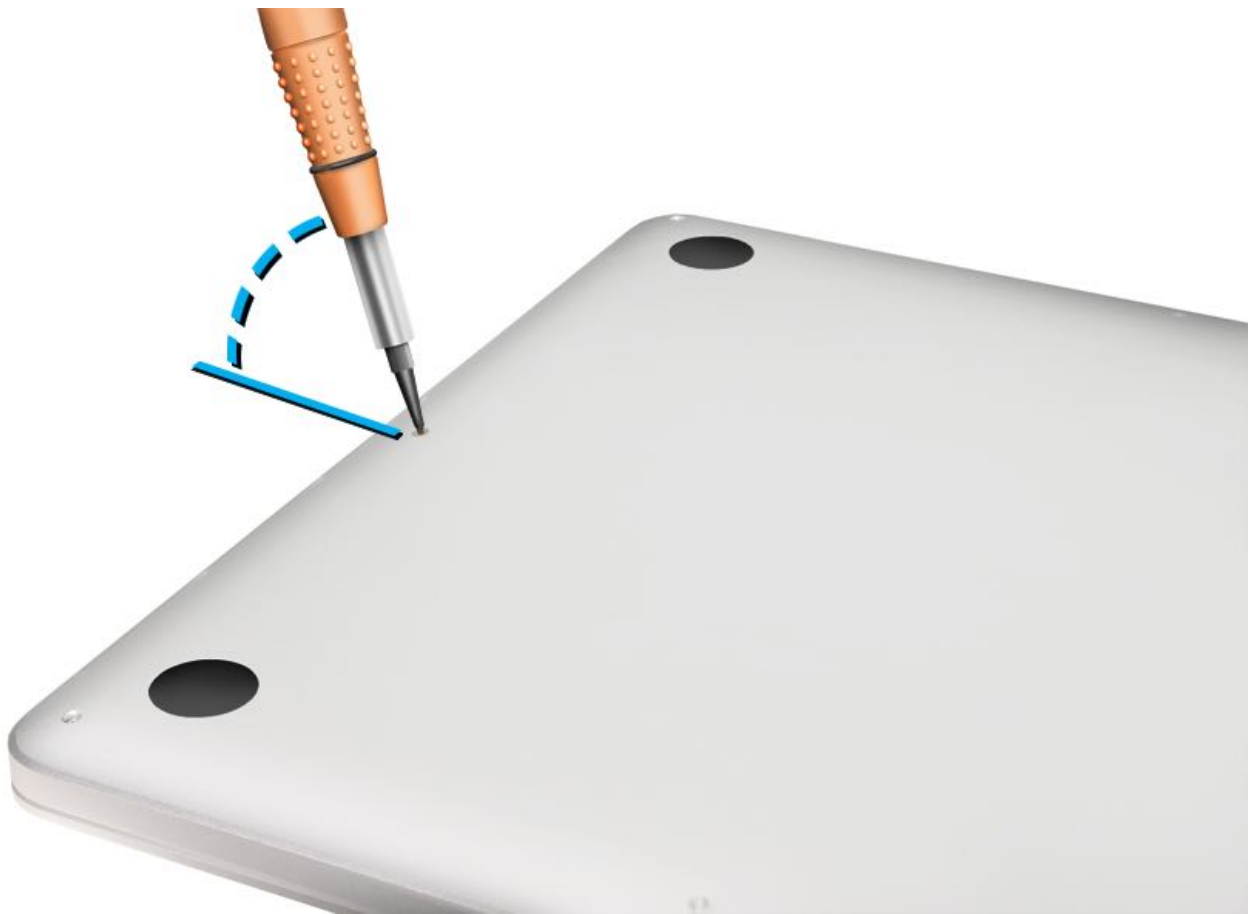
1. Remove ten pentalobe security screws in the order shown in the graphic. **Important:** Screws must be removed and installed at an angle.

- Two screws (2.0 mm) at positions #1 and #3 in graphic.
  - Mid 2012–Mid 2014: 923-0132
  - Mid 2015: 923-00540



- Eight screws (2.8 mm) at positions #2 and #4–10 in graphic.
  - Mid 2012 and Early 2013: 923-0131
  - Late 2013, Mid 2014, and Mid 2015: 076-00003





2. Use a black stick to loosen and remove the bottom case.

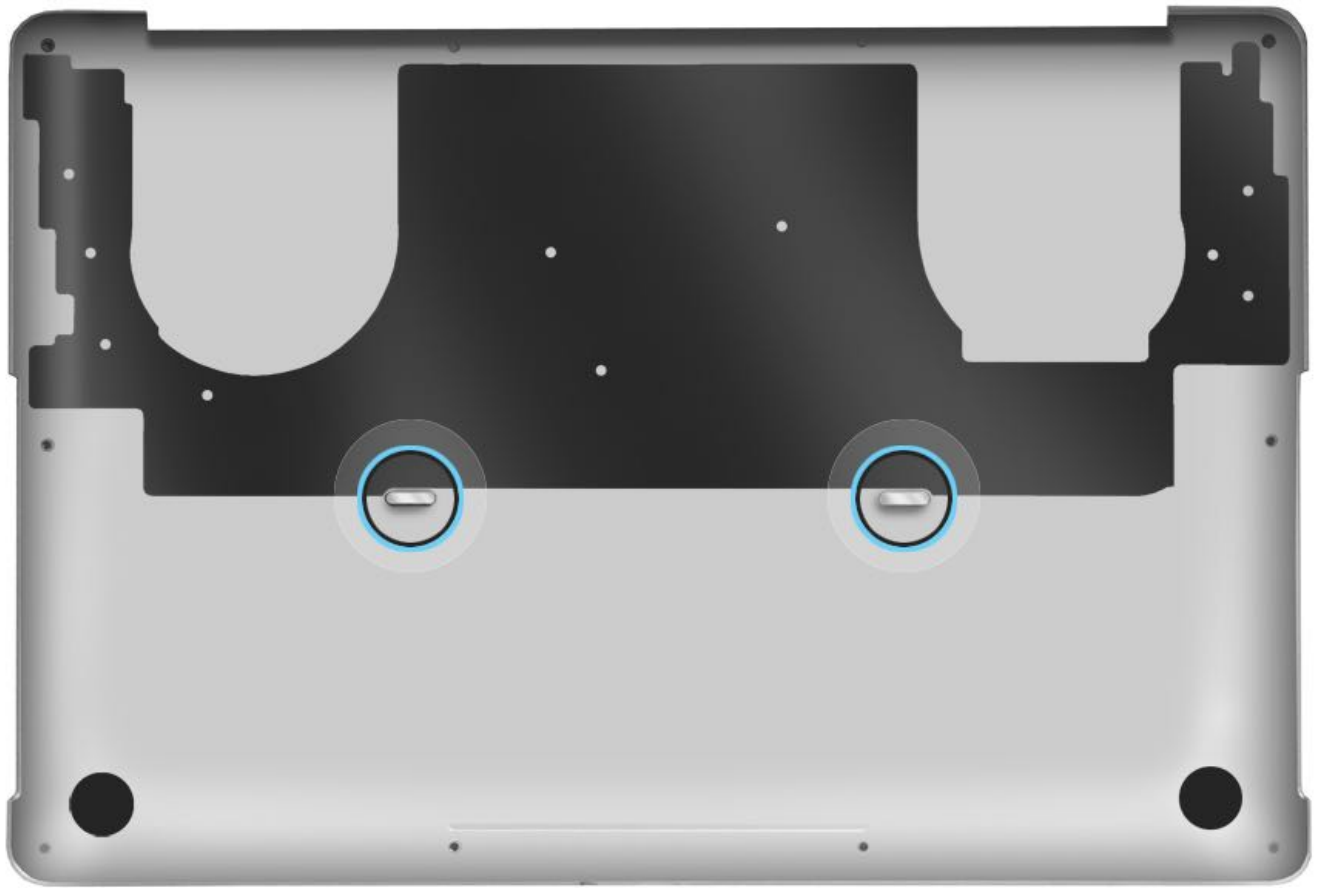


**Important:** Always [attach the battery cover and disconnect the battery cable](#) immediately after removing the bottom case.



### Steps For Reassembly

1. Check that the bottom case interior is clean and free of debris.
2. Install the bottom case so that the two clips snap onto the top case.
3. Confirm that all screw holes align before installing the screws.



**Note:** Images shown are representative. Your model may differ slightly.

4. Install ten screws in the order shown in the graphic. If this sequence is not followed, the bottom case may wobble when placed on a level surface.

**Important note for MacBook Pro (Retina, 15-inch, Late 2013) only:** Do not install the original screws you removed from the bottom case. Instead, use the screws included with the bottom case service part (if replacing the bottom case) or the screws in Apple screw kit 076-00003.

- Two screws (2.0 mm) at positions #1 and #3 in graphic
  - Mid 2012 and Early 2013: 923-0132
  - Late 2013 and Mid 2014: 076-00003
  - Mid 2015: 923-00540

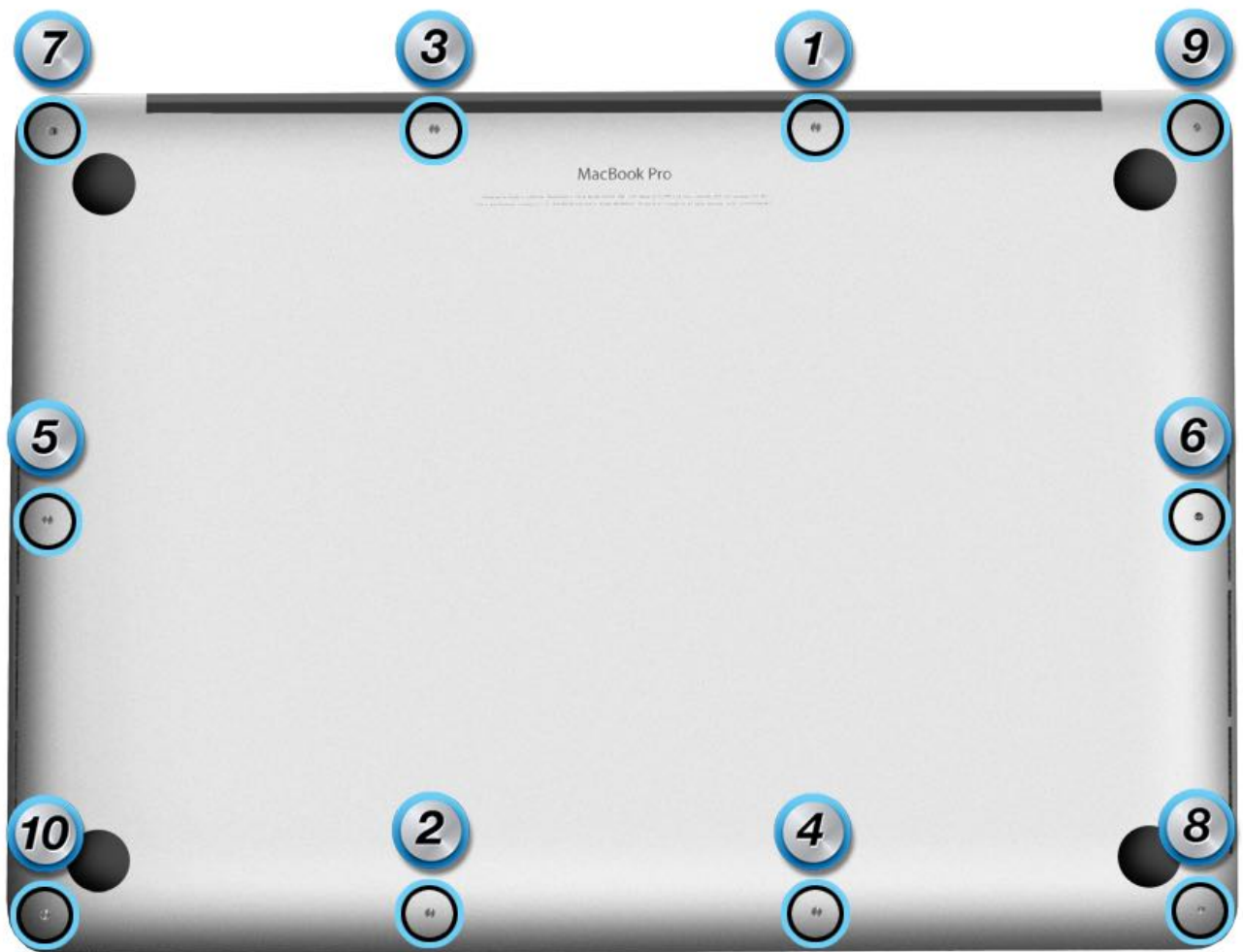


- Eight screws (2.8 mm) at positions #2 and #4 and #5–10 in graphic
  - Mid 2012 and Early 2013: 923-0131
  - Late 2013 and Mid 2014: 076-00003



**Note:** To prevent offsetting the bottom case, press with two fingers around each screw hole before and during screw installation.





5. For MacBook Pro (Retina, 15-inch, Mid 2015) only: Trackpad performance must be validated after every repair.

# Battery Cover and Cable

## First Steps

**Important:** This procedure should only be performed by Apple-certified technicians.

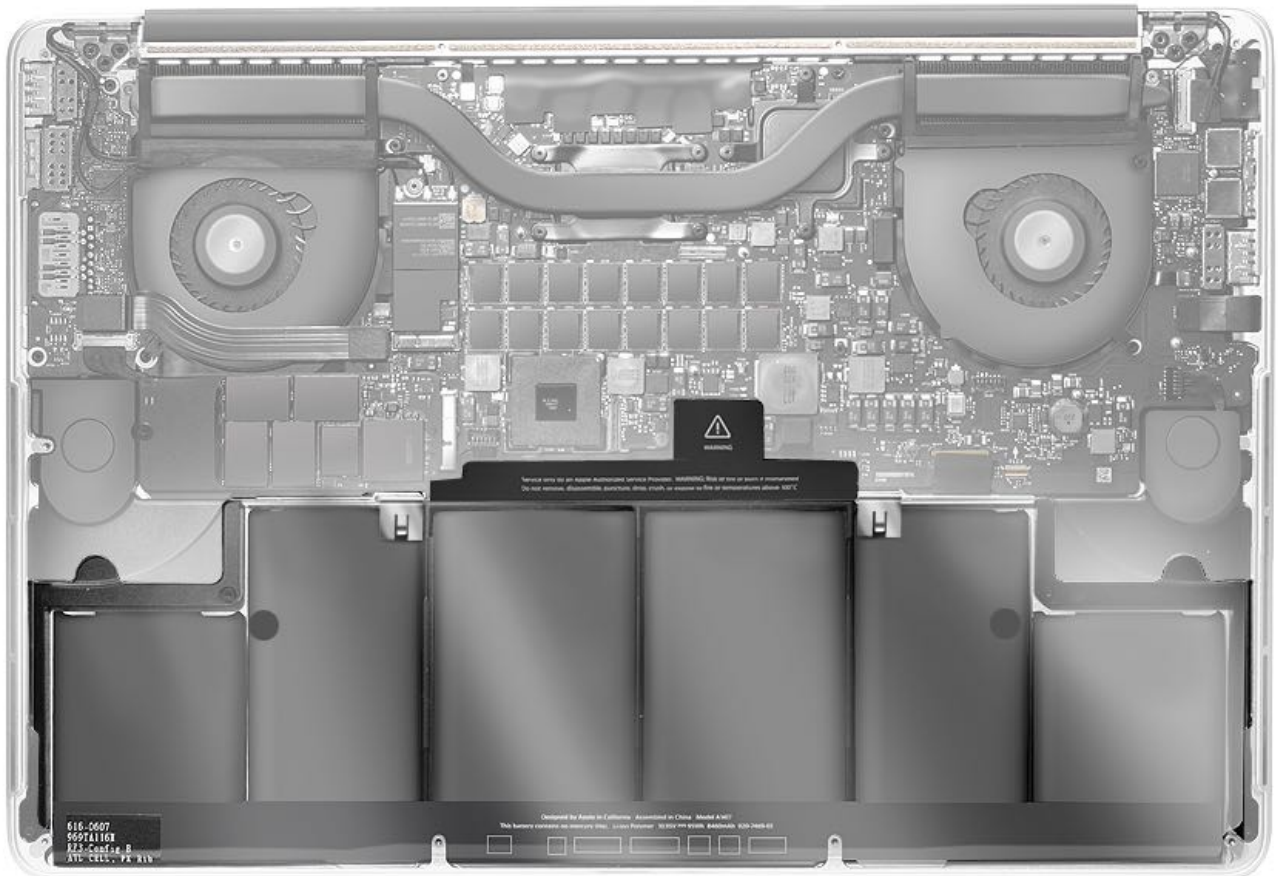
Remove:

- [Bottom case](#)



**Warning:** Always attach the battery cover and disconnect the battery cable immediately after removing the bottom case. The battery is part of the top case module. Do not attempt to remove the battery from the top case.

This image is representational of most models. **Note:** On MacBook Pro (Retina, 15-inch, Mid 2015), the trackpad flex cable runs over the battery.



## Tools

- ESD wrist strap
- Black stick



## Steps For Removal

1. Tilt the bottom tabs of the battery cover into the slots at the bottom edge of the top case.
2. Carefully lower the cover onto the battery cells, making sure the tabs on the sides of the cover fit into the notches on the side edges of the top case.

**Note:** Battery covers for MacBook Pro (Retina, 15-inch, Mid 2012 and Early 2013) attach with magnetic snaps.

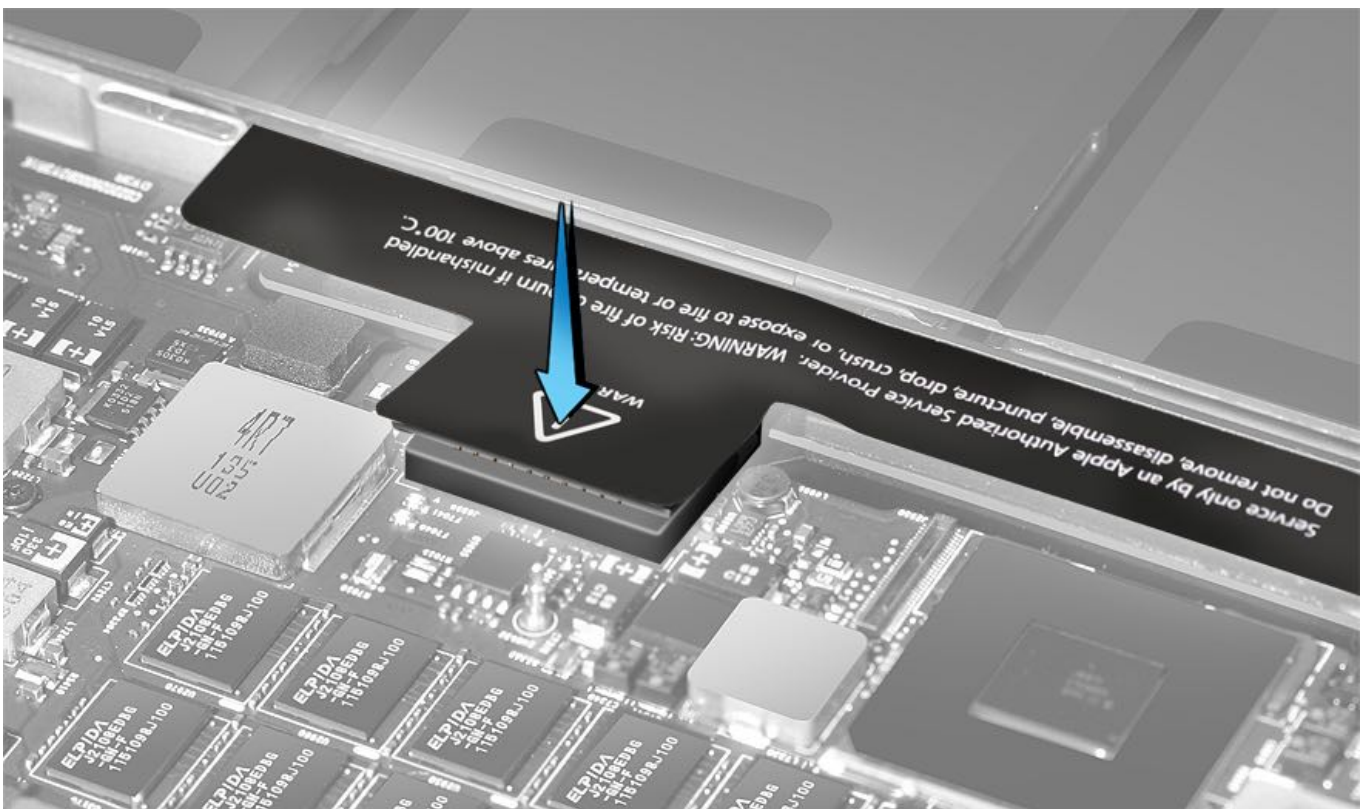
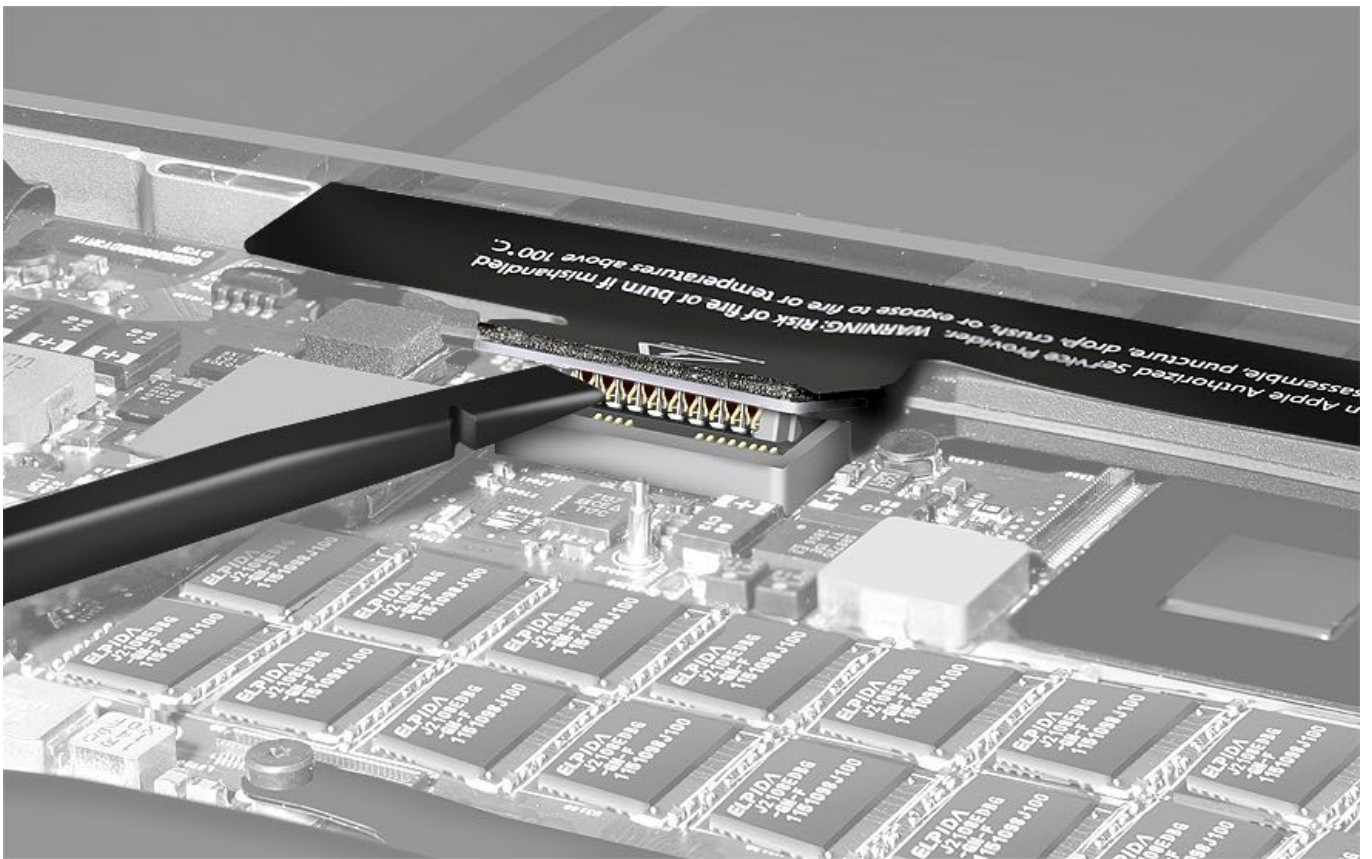


3. Use a black stick to disconnect the battery cable from the logic board. **Caution:** Use only a black stick or other nonconductive flat-blade tool.

## Reassembly Notes:

- To reconnect the battery cable, align the cable connector with the logic board connector and press straight down on top of the cable connector.
- Before installing the bottom case, remove the battery cover. The cover can be reused for another repair if it is free of dust, dirt, or other debris.





## Steps For Reassembly

Reassemble in reverse order of removal steps.

**For MacBook Pro (Retina, 15-inch, Mid 2015) only:** Trackpad performance must be validated after every repair.

# Trackpad Flex Cable

## First Steps

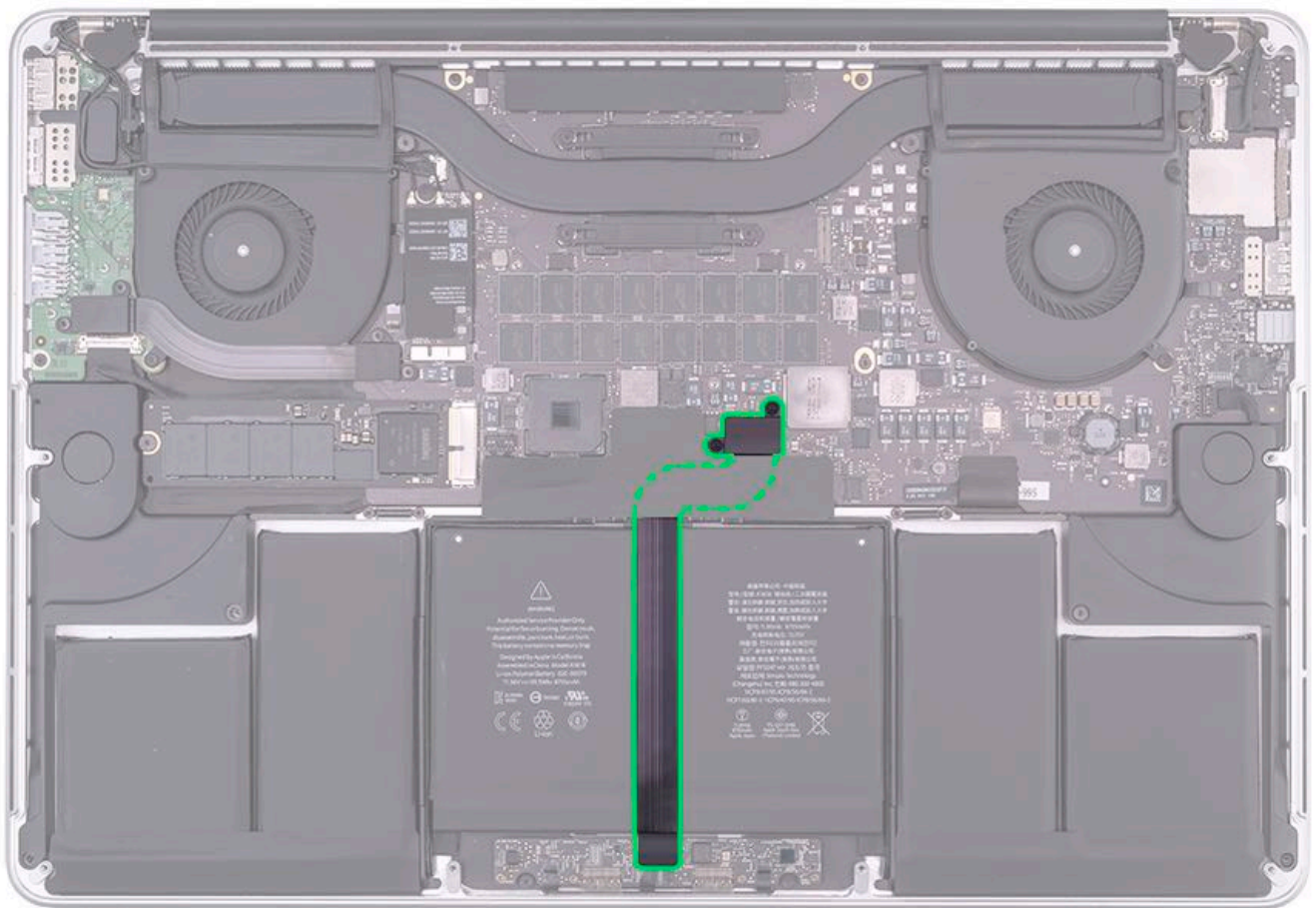
**Important:** This procedure should only be performed by Apple-certified technicians.

Remove:

- [Bottom case](#)

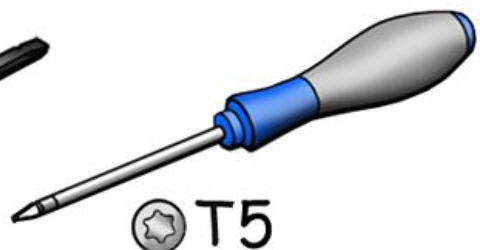


**Caution:** Always [attach the battery cover and disconnect the battery cable](#) immediately after removing the bottom case.



## Tools

- ESD wrist strap
- Black stick
- Torx T5 screwdriver (magnetized)



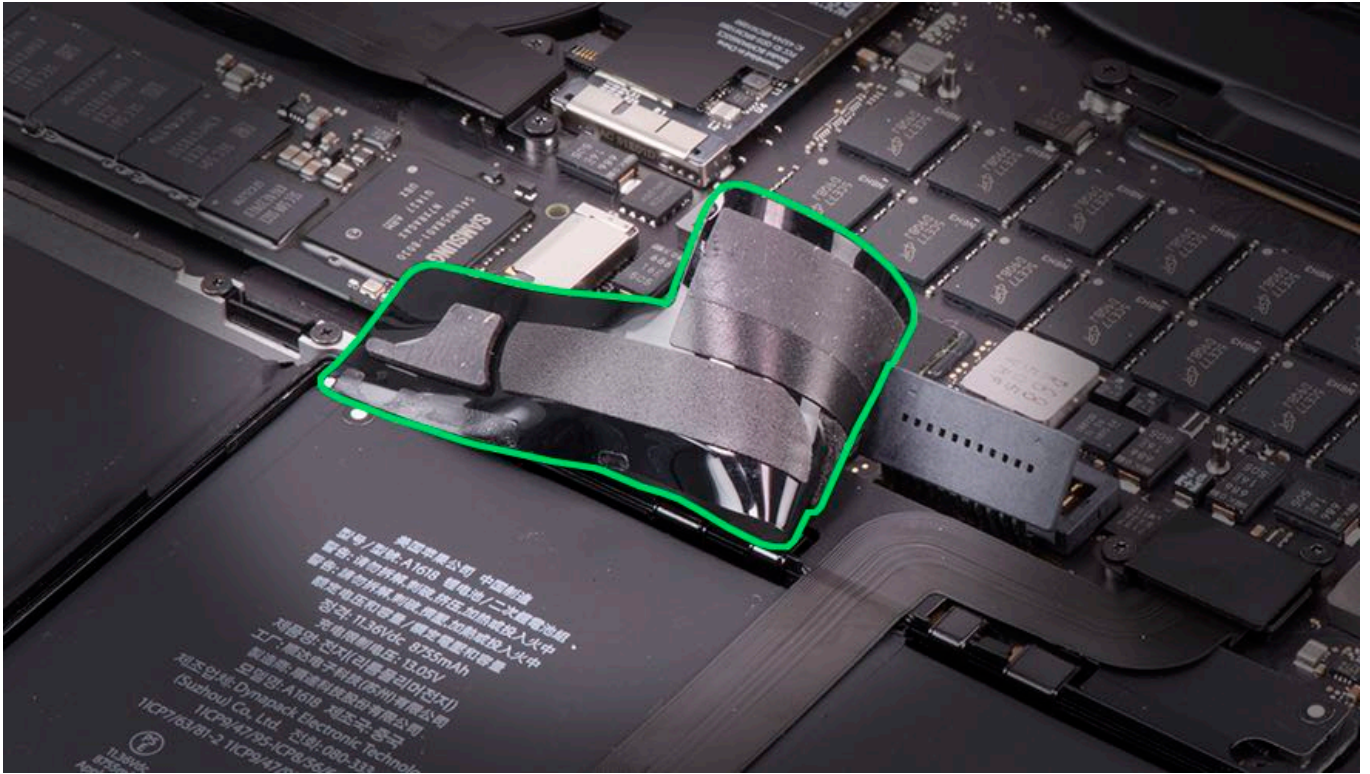


## Steps For Removal



**Warning:** This procedure is performed in close proximity to the battery. Follow safety precautions at all times.

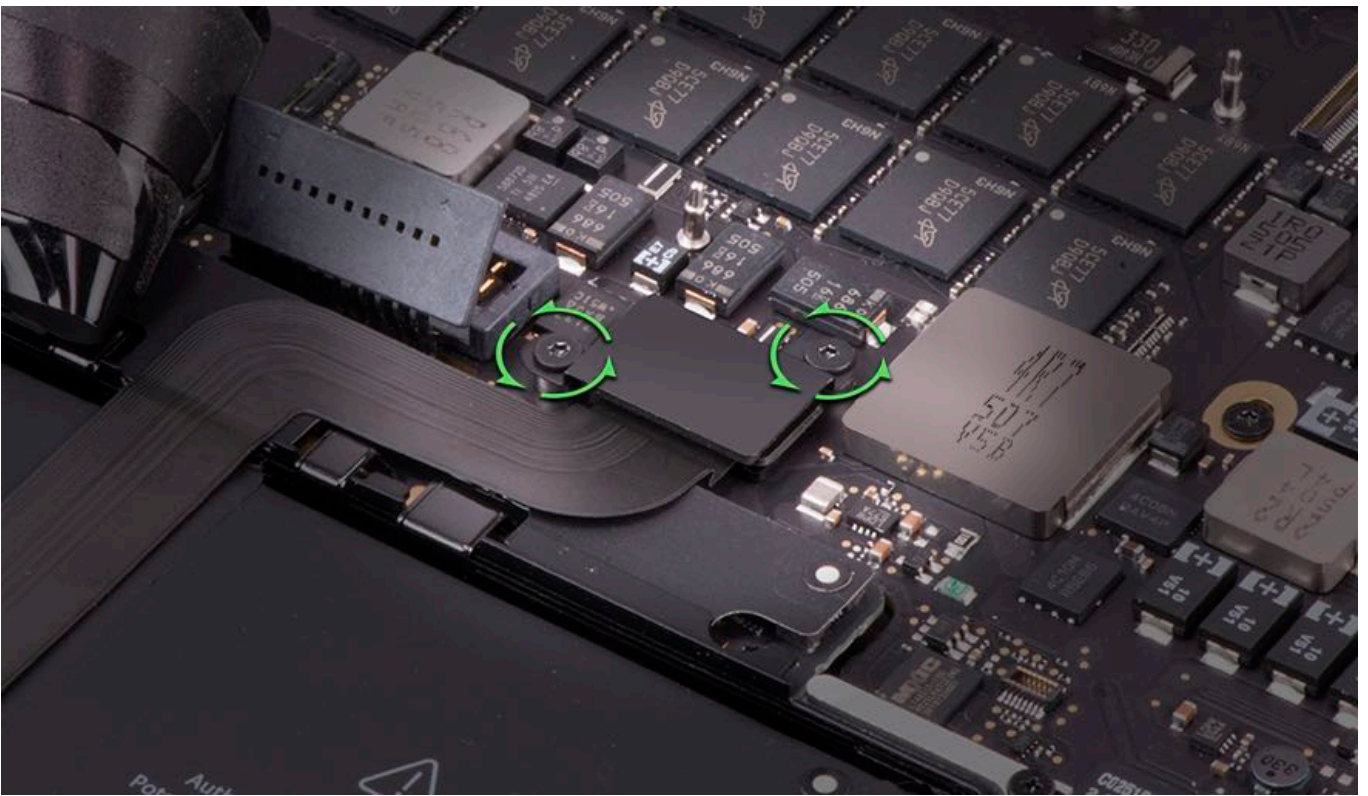
1. Peel back the Mylar that covers the battery connector and the trackpad connector.



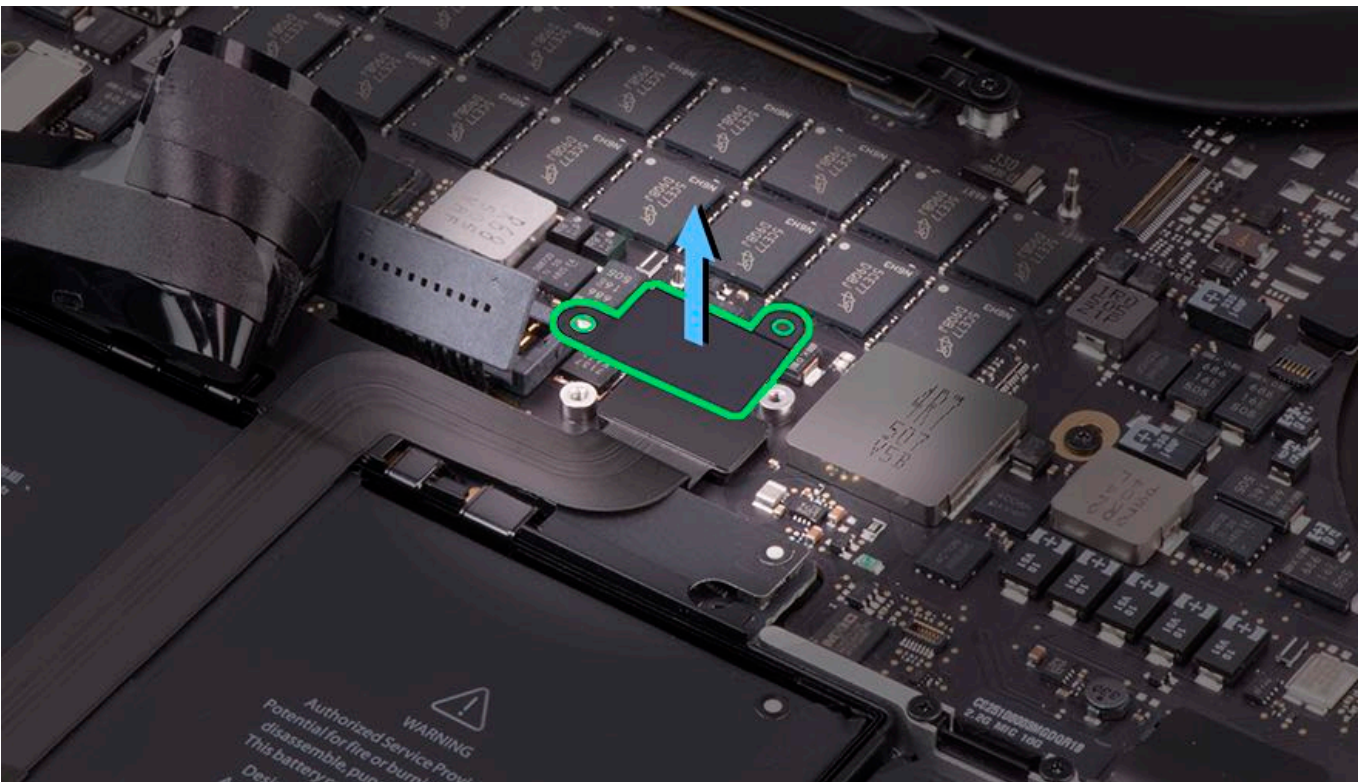
2. Remove two T5 screws from the metal bracket on the logic board side of the trackpad flex cable.

- T5: 923-00523



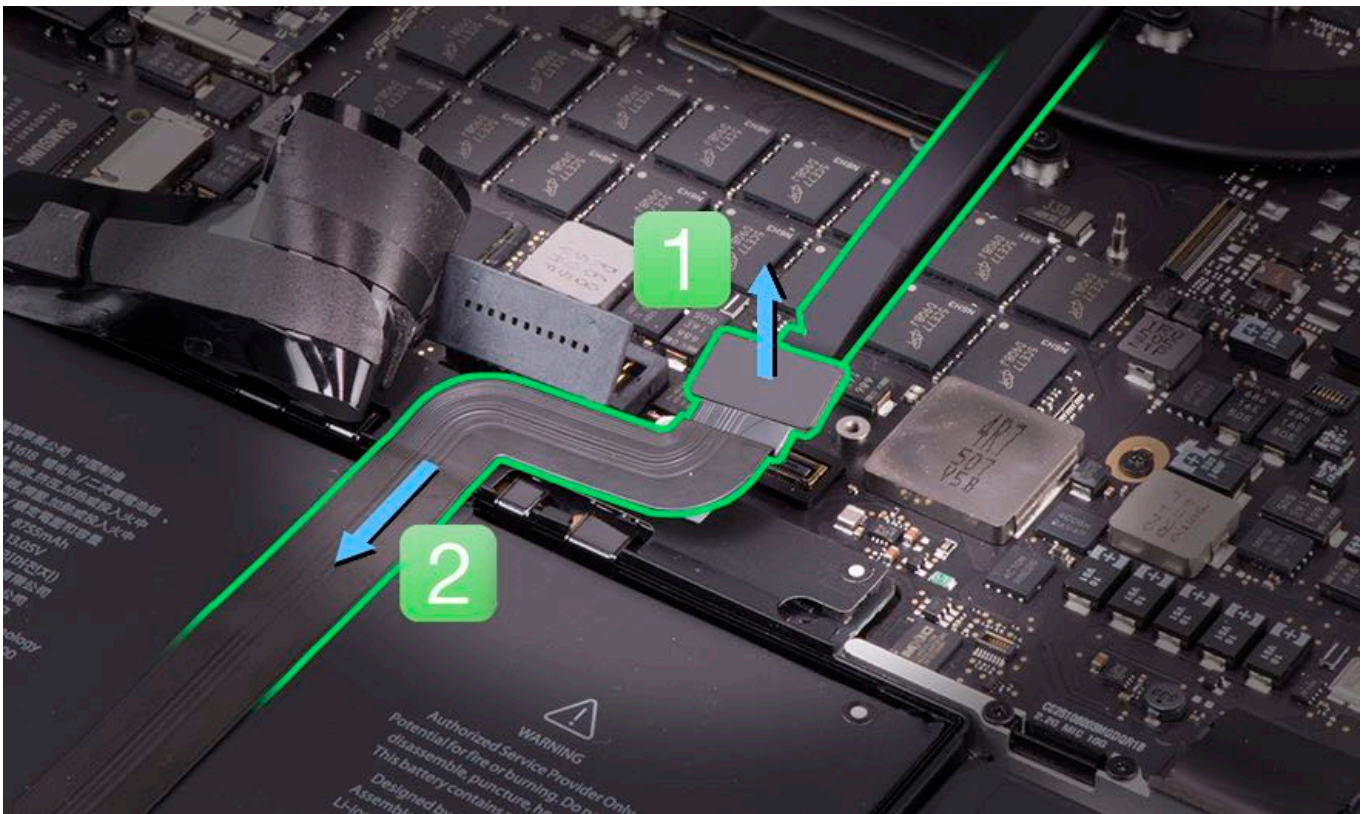


3. Remove the metal bracket and set it aside for reuse.

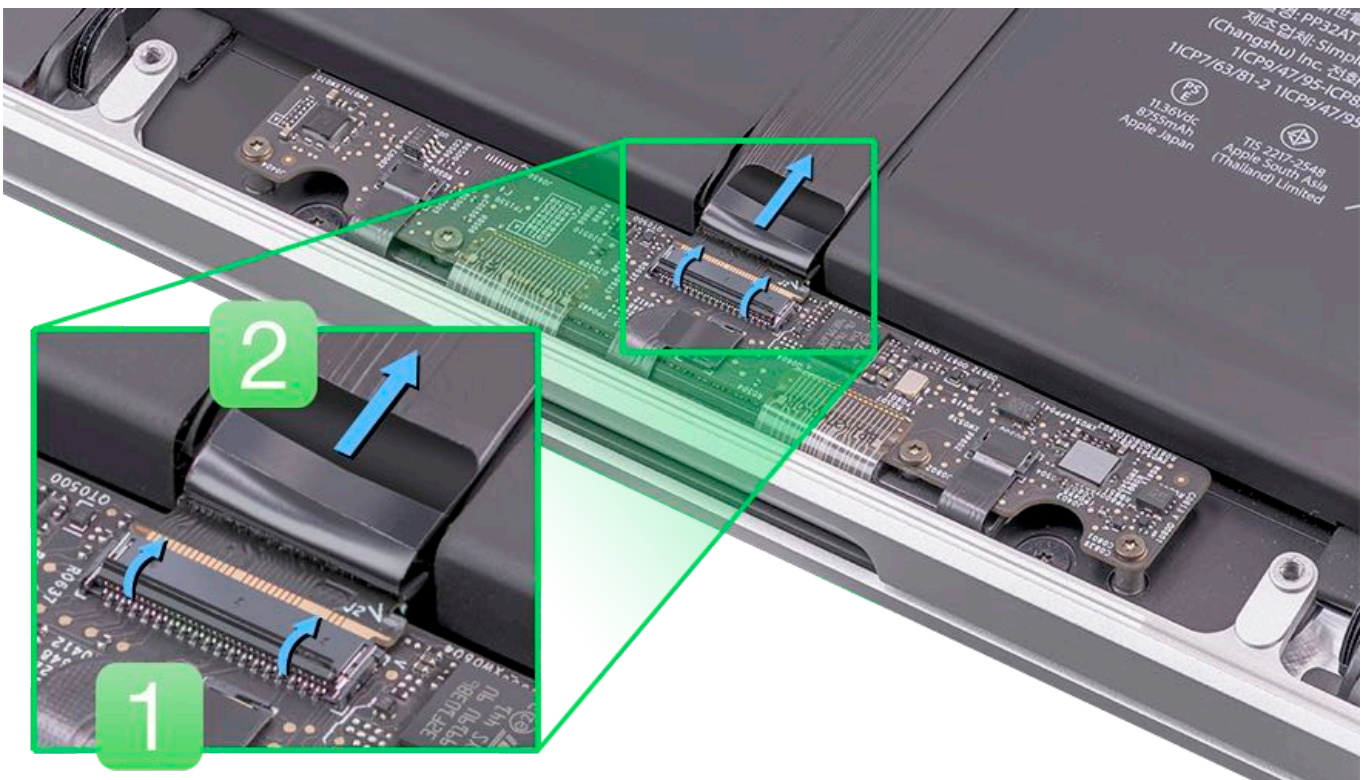


4. Use a black stick to lift the the trackpad flex cable connector (1) from the logic board. Carefully peel the cable (2) off the battery, toward the other end of the cable. **Caution:** Keep the trackpad flex cable as flat as possible. If the cable is crimped or wrinkled, it may have to be replaced.





5. With a black stick, flip the locking lever (1) up and gently pull the Mylar tab (2) to disconnect the trackpad flex cable from the connector. **Note:** Press the locking lever down (closed position) to avoid damage to the connector.



## Steps For Reassembly

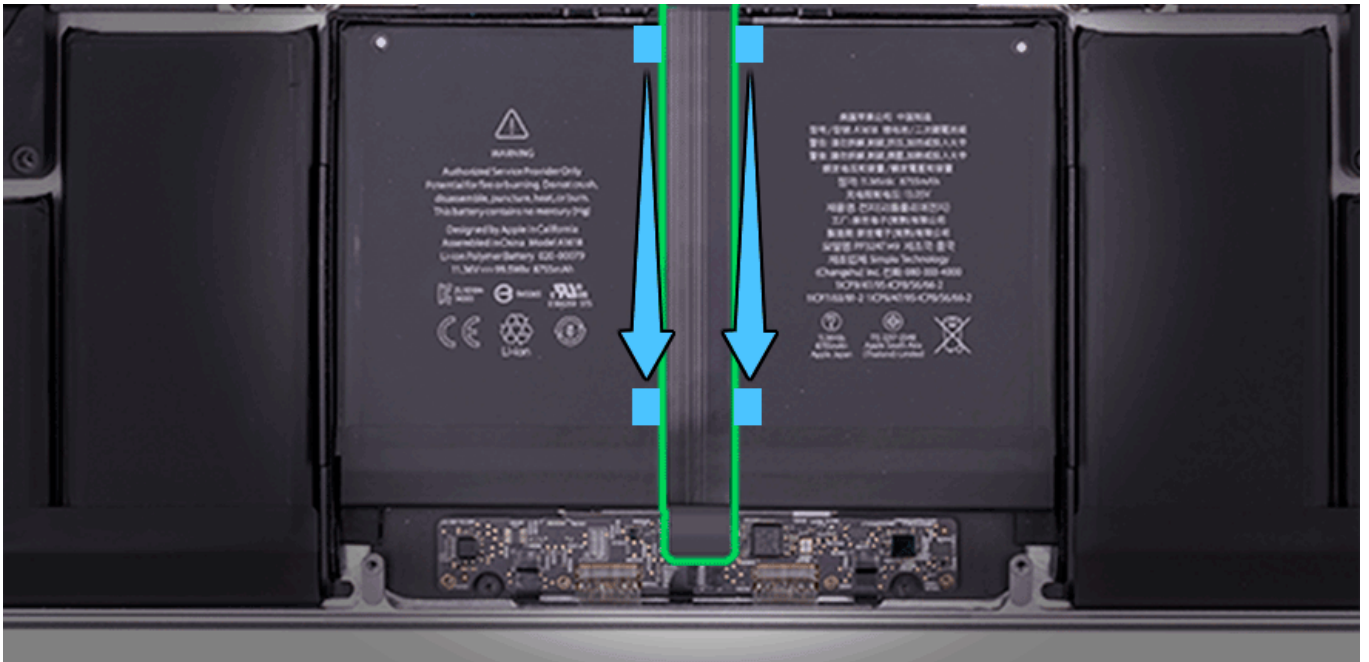


**Warning:** This procedure is performed in close proximity to the battery. Follow safety precautions at all times.

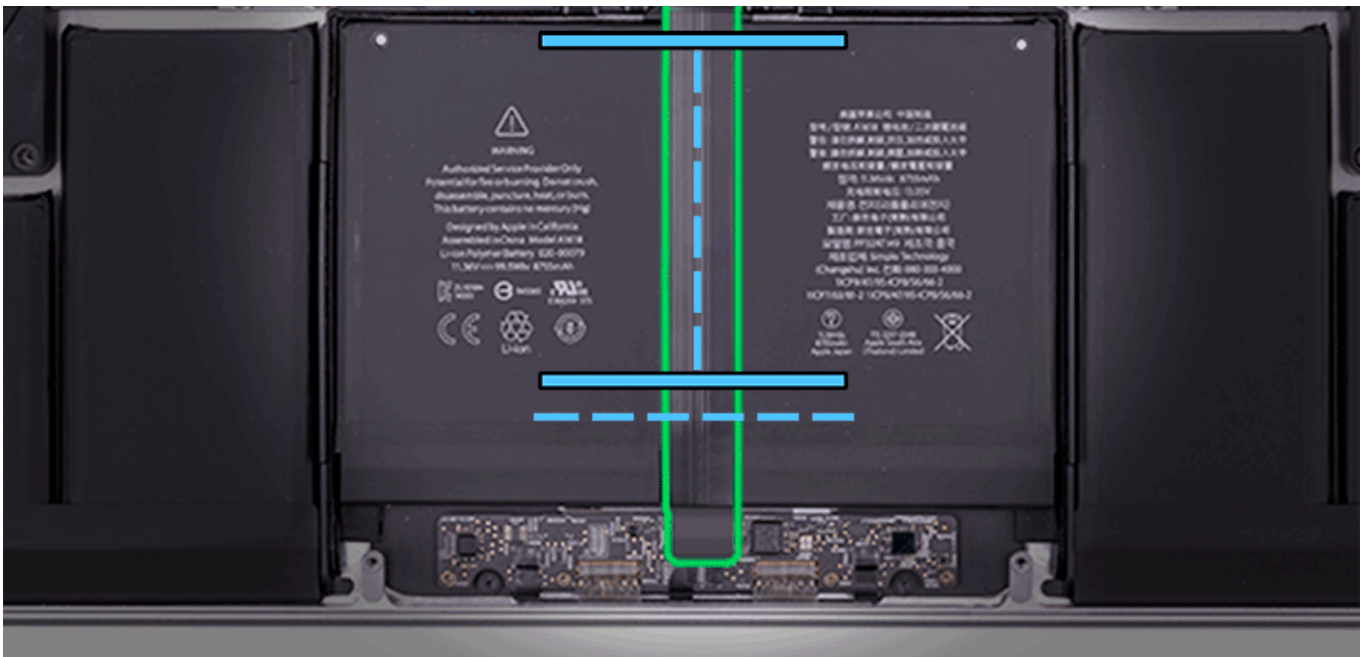
1. If reinstalling the trackpad flex cable, reassemble in reverse order or removal steps.

**Note:** The following steps are to be used when replacing the trackpad flex cable.

2. A replacement trackpad flex cable comes with adhesive backing. Be sure both ends of the cable are attached before removing the adhesive backing.
3. To remove the adhesive backing, pull the two blue pull-tabs (on the underside of the flex cable) in a downward motion to expose the adhesive backing on the underside of the cable.



4. To secure the cable to the battery, start at the top of the cable and carefully apply light pressure with your finger. Press in the middle along the vertical dotted line. Do not press on the lower end of the cable below the horizontal dotted line.



5. Trackpad performance must be validated after every repair.



# Solid-State Drive (SSD) Card or Flash Storage

## First Steps

**Important:** This procedure should only be performed by Apple-certified technicians.

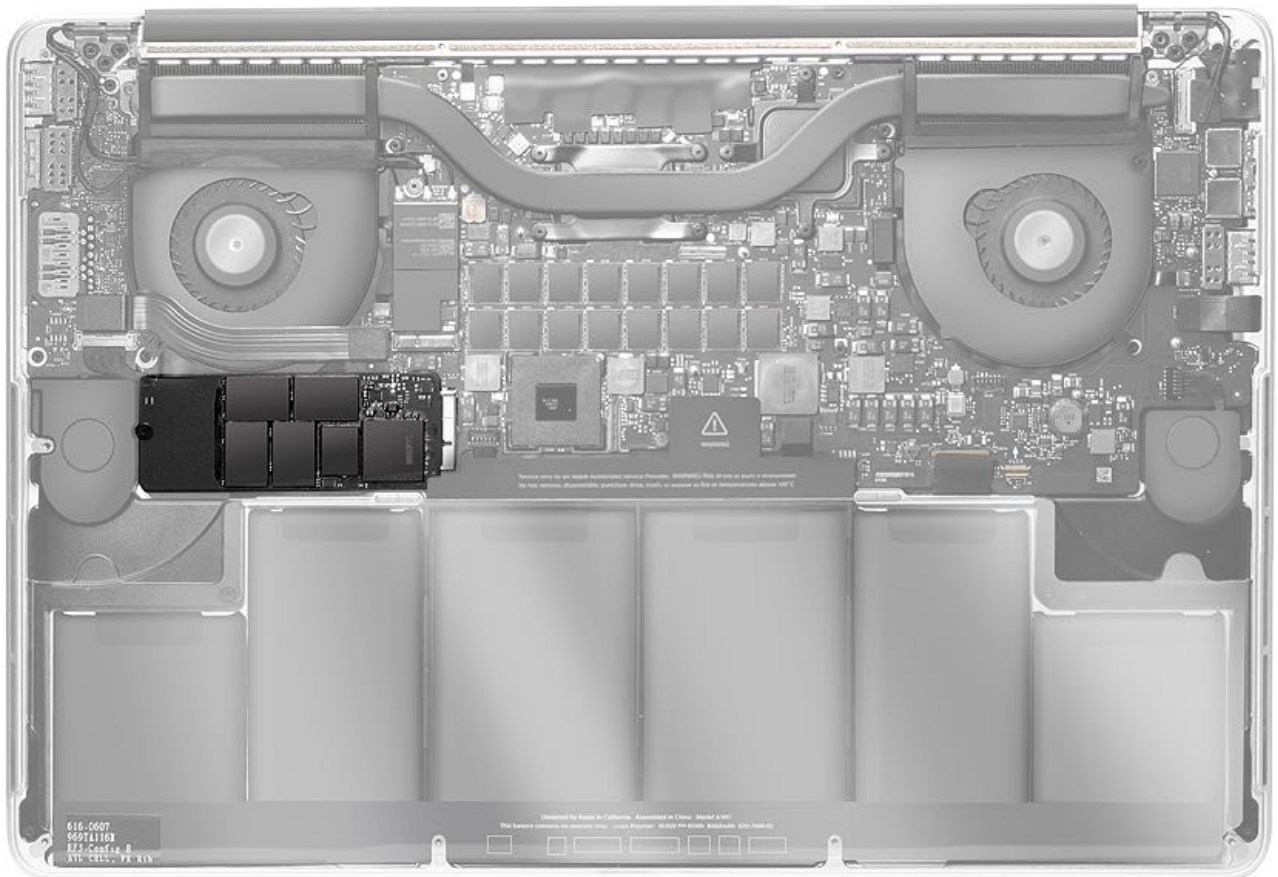
Remove:

- [Bottom Case](#)



**Warning:** Always attach the [battery cover and disconnect battery cable](#) immediately after removing bottom case.

**Caution:** Make sure all data is backed up before removing the SSD card or flash storage.



## Tools

- ESD wrist strap
- Torx T5 screwdriver (magnetized)

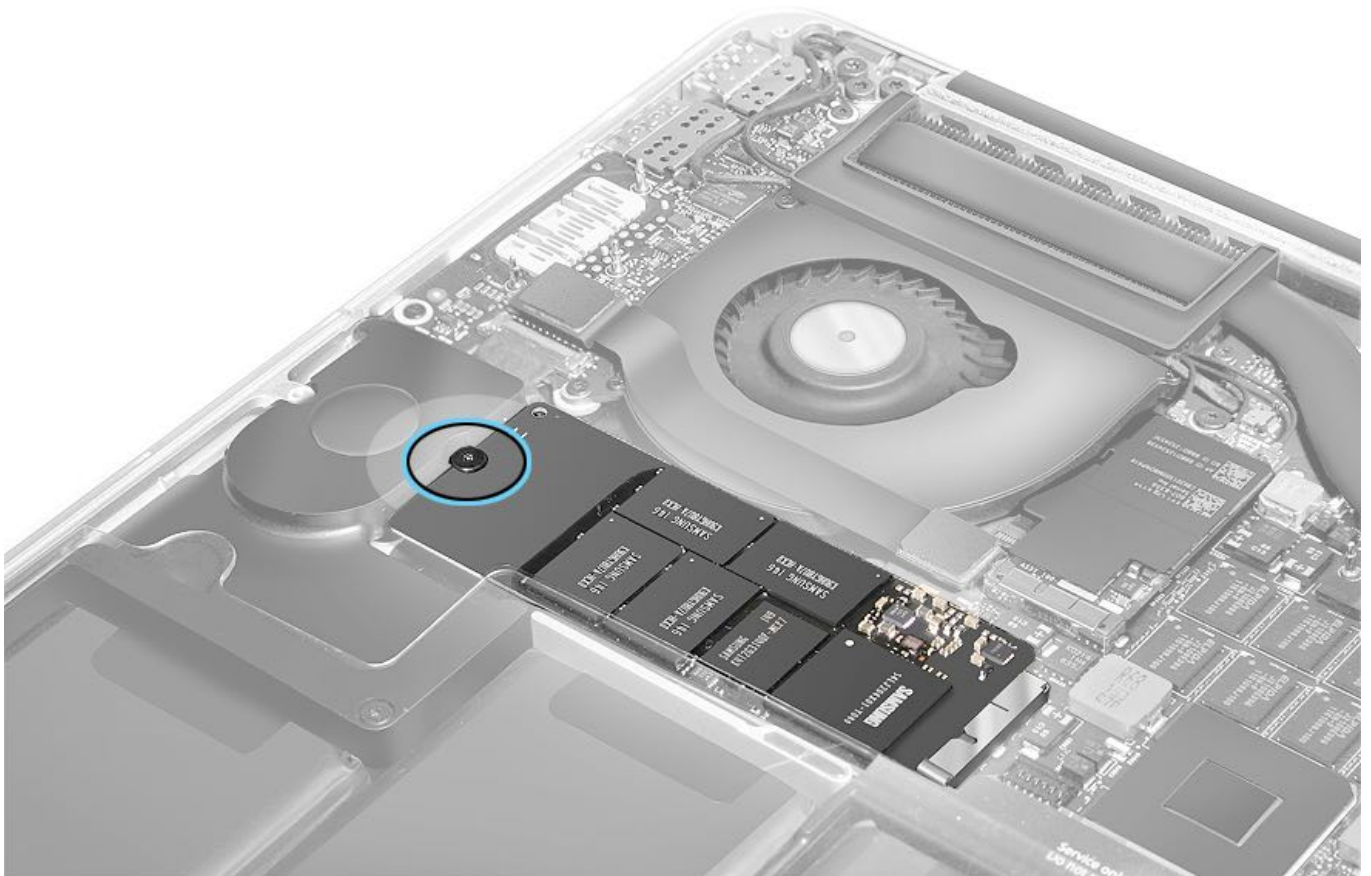




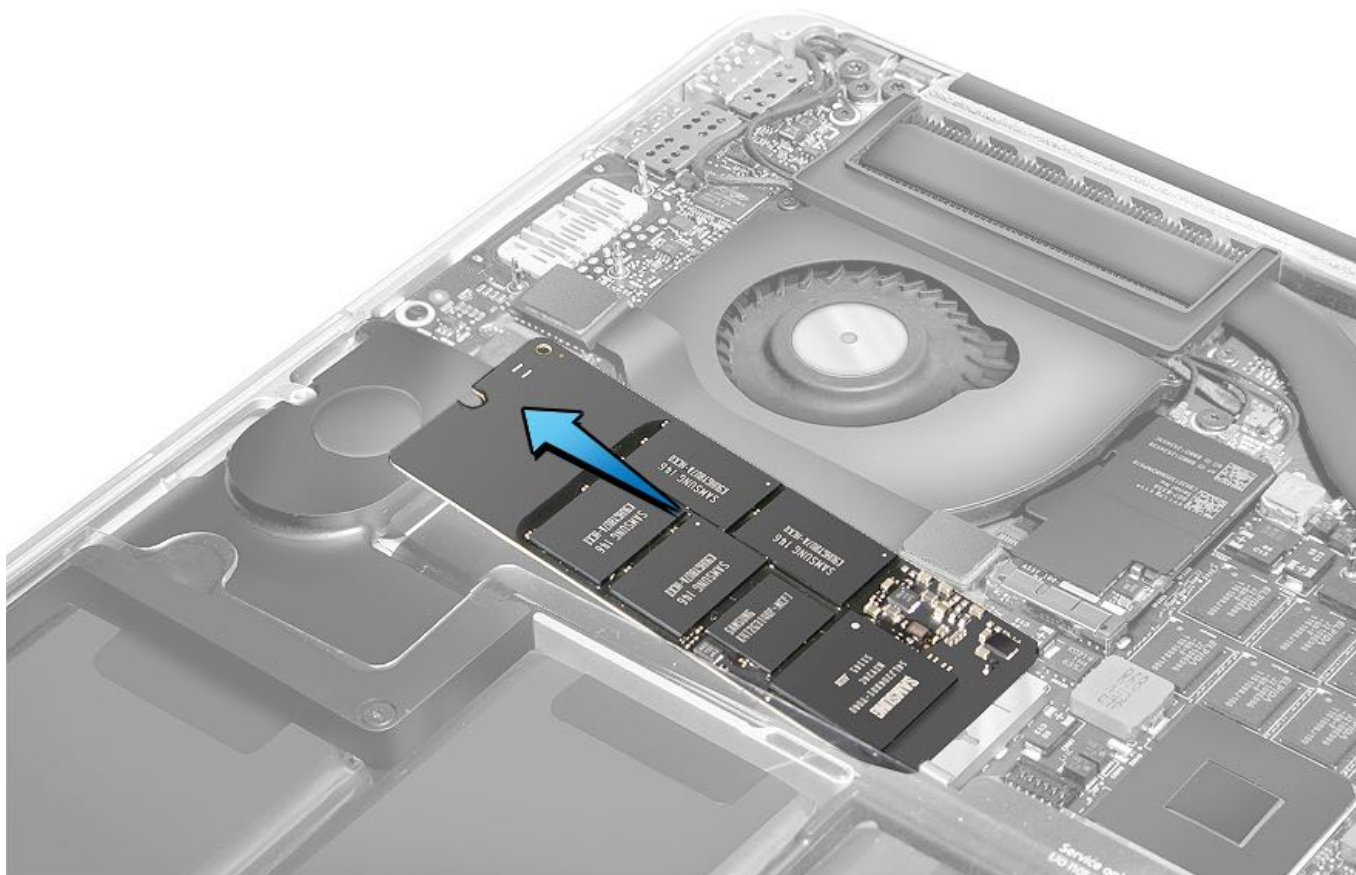
## Steps For Removal

1. Remove one Torx T5 screw:

- 923-0161 (1.7 mm)



2. Tilt the card up at a slight angle ( $< 3$  degrees) and gently pull to disconnect the card from the logic board.



## Steps For Reassembly

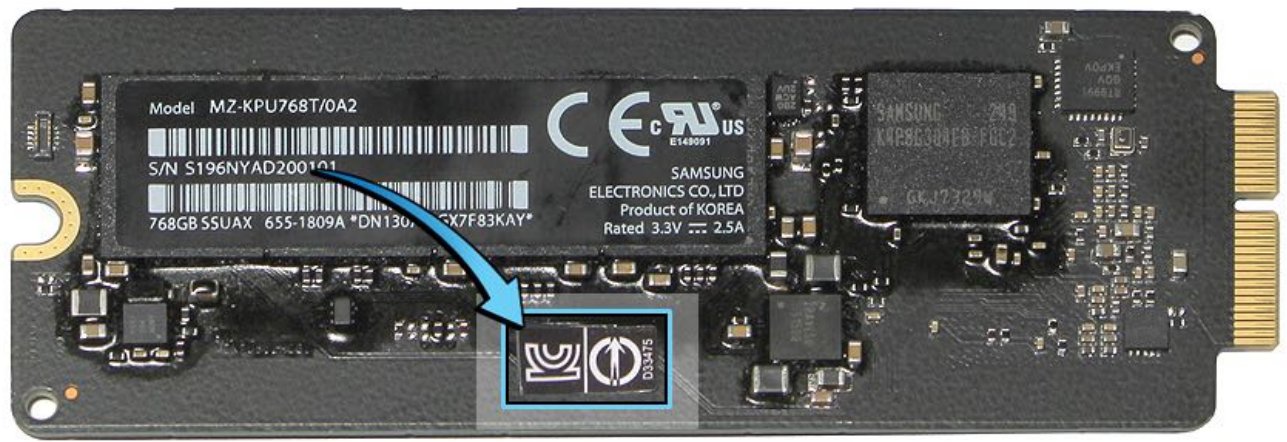
**Note:** Before installing a replacement card in the computer, peel off the compliance label attached to the underside of the card.

**MacBook Pro (Retina, 15-inch, Mid 2012 and Early 2013)**

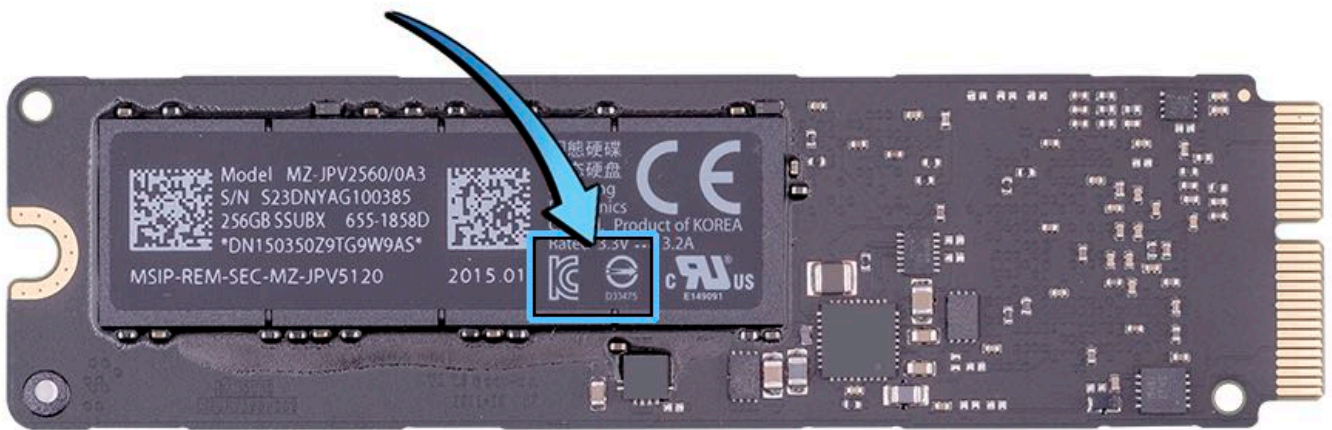


**MacBook Pro (Retina, 15-inch, Late 2013 and Mid 2014)**

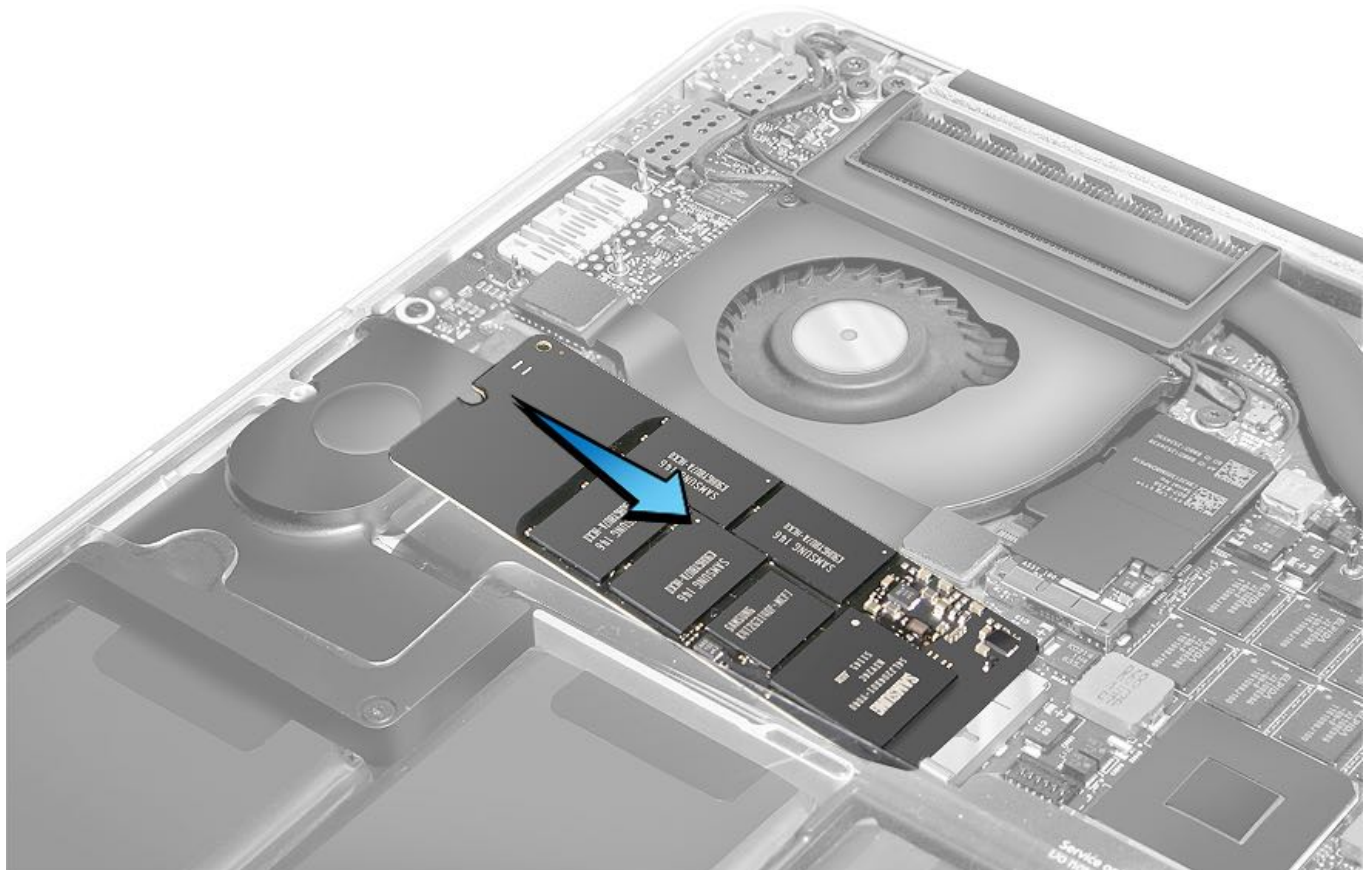




MacBook Pro (Retina, 15-inch, Mid 2015)

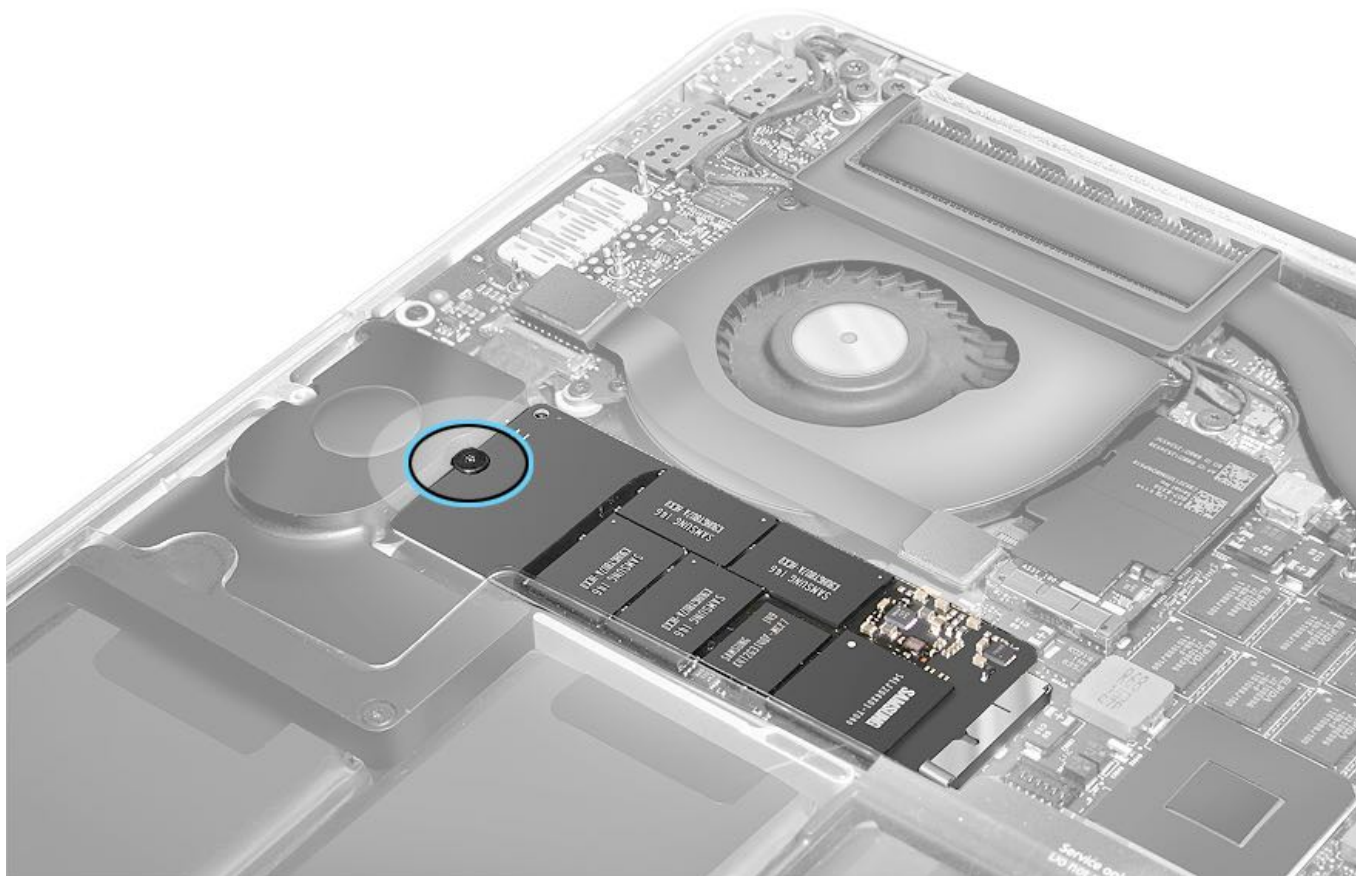


1. Insert the card securely into the slot and confirm that it is seated properly.



2. Install one Torx T5 screw:

- 923-0161 (1.7 mm)



3. Continue to reassemble in reverse order of removal steps.
4. **For MacBook Pro (Retina, 15-inch, Mid 2015) only:** Trackpad performance must be validated after every repair.
5. **Reinstalling Software That Came with the Computer:** Software install media does not come with this computer.

# Reinstalling Software That Came with the Computer

## Reinstalling Software That Came with the Computer

This procedure requires an Internet connection.

**Note:** In some situations, a user may have set a firmware password via a feature such as Find My Mac or FileVault. The user must know the firmware password in order to reinstall OS X or macOS.

**Important:** Apple recommends that users back up their data before any software restore procedure. Back up essential files before installing OS X or macOS. Apple is not responsible for any loss of data.

1. Choose Apple menu > Restart, then hold down the Command (⌘) and R keys while the computer restarts.  
**Note:** To force OS X Lion or later, or macOS Sierra, into Internet Recovery, press and hold the Command-Option-R key combination while starting up the computer.
2. If the computer is not connected to the Internet, choose a network from the Wi-Fi menu (in the top-right corner of the screen).
3. Select "Reinstall OS X" (or macOS), then click Continue.
4. Follow the onscreen instructions. In the pane where you select a disk, select your current OS X or macOS disk (in most cases, it is the only one available).
5. To start the installation, click Install.

Check for and apply the latest software and firmware updates.



# Wireless Card

## First Steps

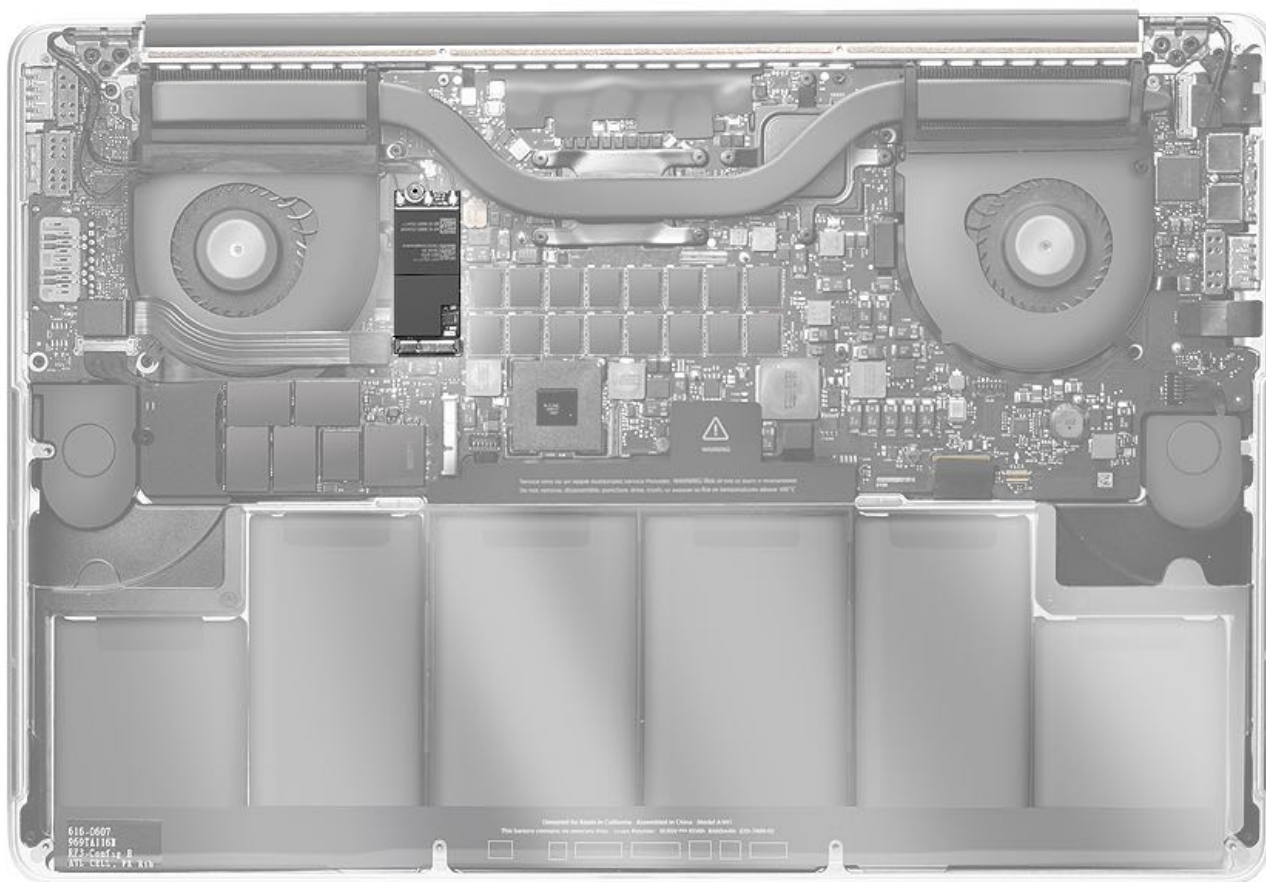
**Important:** This procedure should only be performed by Apple-certified technicians.

Remove:

- [Bottom Case](#)



**Warning:** Always [attach the battery cover and disconnect the battery cable](#) immediately after removing the bottom case.



## Tools

- ESD wrist strap
- ESD-safe plastic or nylon tweezers
- Torx T5 screwdriver (magnetized)



## Steps For Removal

**Important:** A thermal pad is adhered to the underside of the wireless card. To avoid damaging the pad, only remove the card from the logic board in two situations:

- Replacing the wireless card
- Transferring the wireless card to a replacement logic board

1. Using tweezers, carefully grip the first cable on the metal extension behind the connector head (the area indicated by the circle). Gently pop the cable straight up off the card.

2. Repeat for the other two antenna cables.

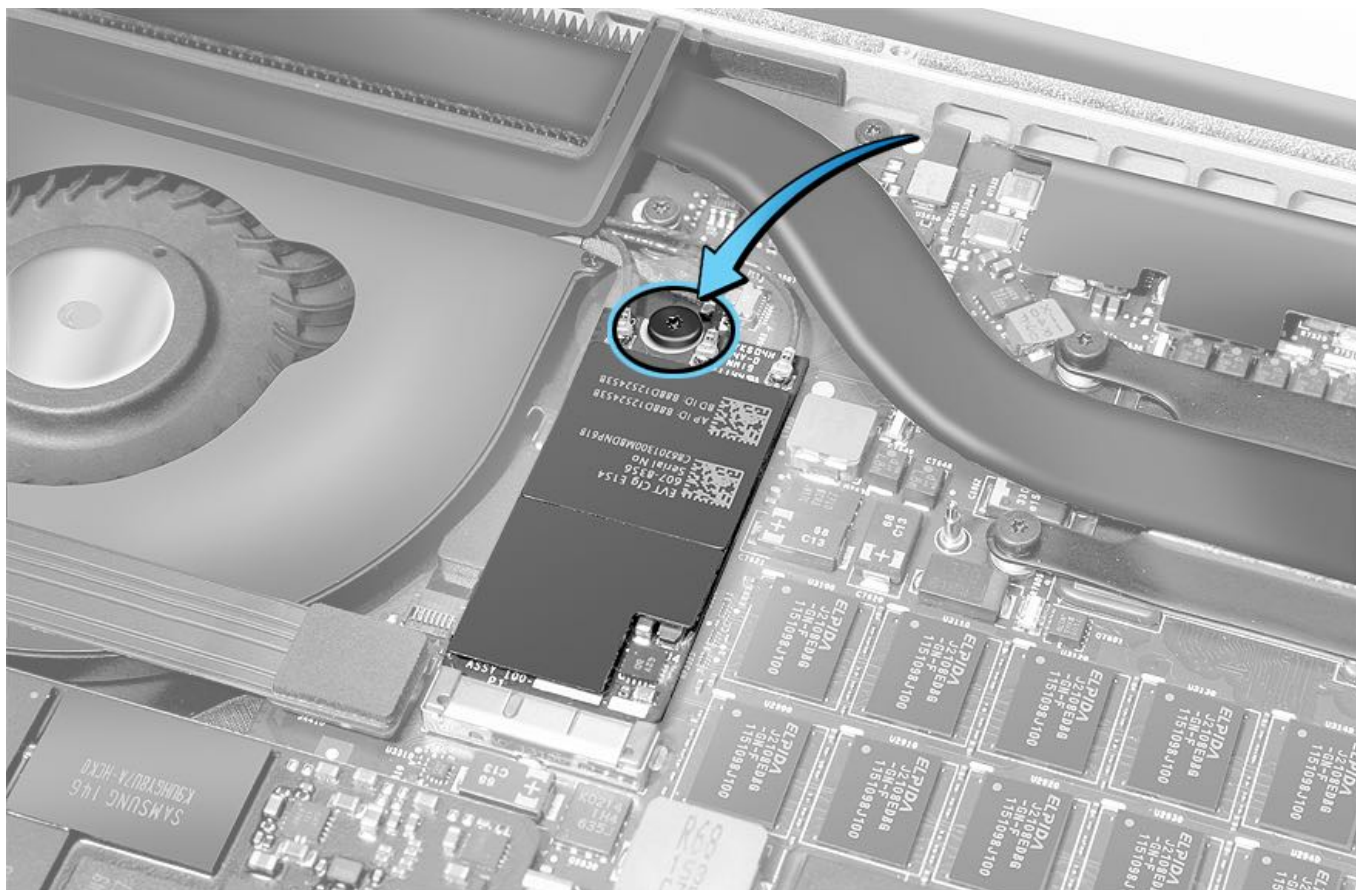
**Important:** Avoid stressing the antenna cables when disconnecting them.



3. Remove Torx T5 screw:

- One 922-9651 (2.0 mm)





4. Try lifting the screw end of the card a short distance. If you feel resistance, use a black stick to carefully loosen the card and the thermal pad from the board.



5. With your fingers, rock and pull the card to disconnect it from the logic board connector.

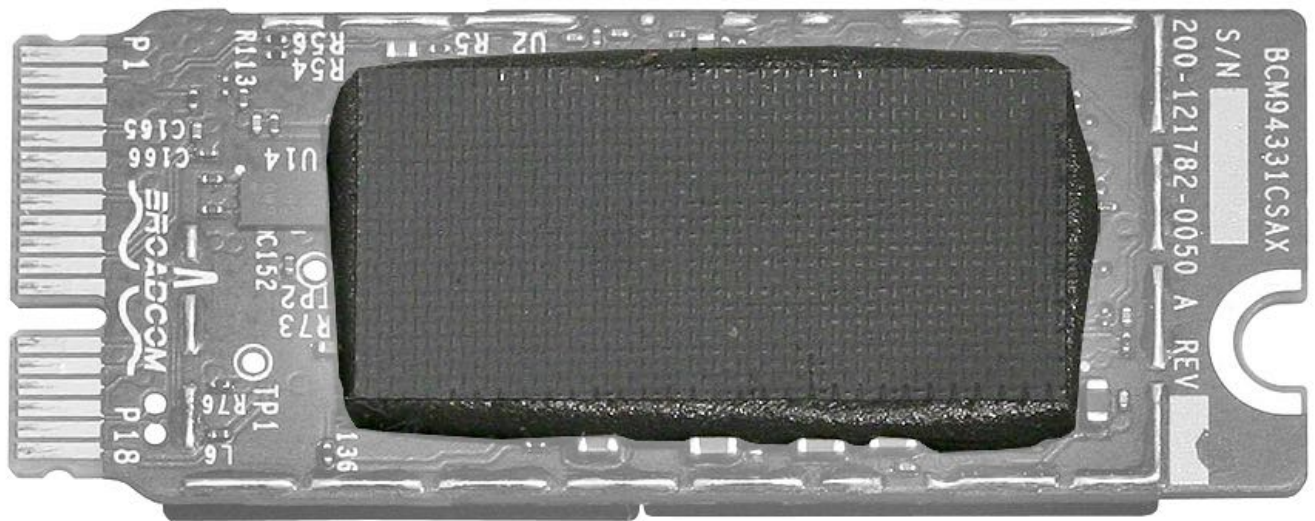
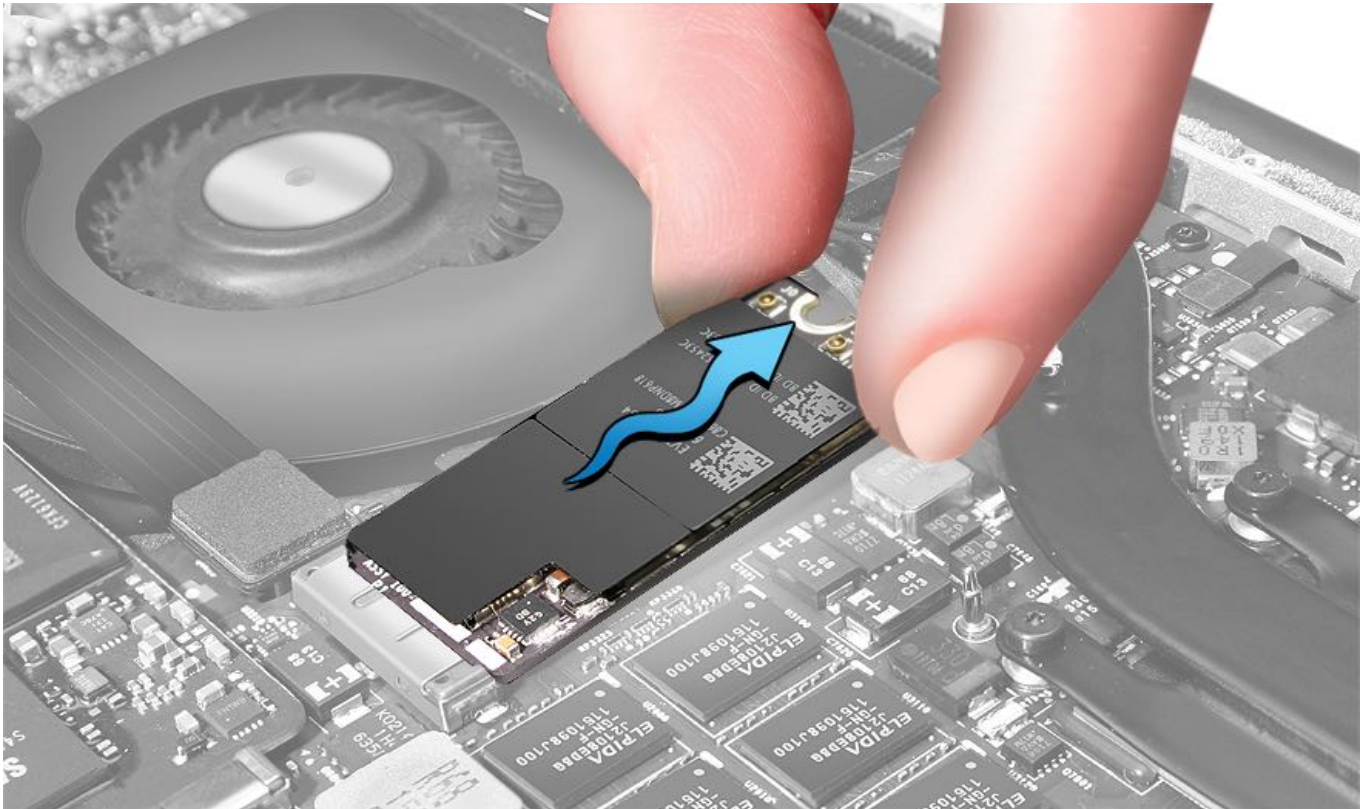
6. Remove the card from the top case.

**Note:** If the card pad adheres to the logic board, carefully peel the thermal pad from the board. Check the board and remove any residue.

If reinstalling the original card, check the thermal pad and reattach it to the underside of the card as shown. If the pad is damaged, attach a new pad (923-0150).



If installing a replacement card, note that replacement cards come with a thermal pad adhered.



### Steps For Reassembly

1. If you are reinstalling the existing card, check that the thermal pad is properly attached to the underside of the card.
2. Insert the card into the logic board connector.
3. Replace Torx T5 screw:
  - One 922-9651 (2.0 mm)



4. Using tweezers, position the antenna cable head over the connector until you feel the cable head seat with the connector. Carefully press straight down with a finger until the head snaps into place. It is important to connect each antenna cable to the correct connector.

**Caution:** Using too much force to reseat the antenna cables can distort the connector or connector rim.



**6. For MacBook Pro (Retina, 15-inch, Mid 2015) only:** Trackpad performance must be validated after every repair.



# Input/Output (I/O) Flex Cable

## First Steps

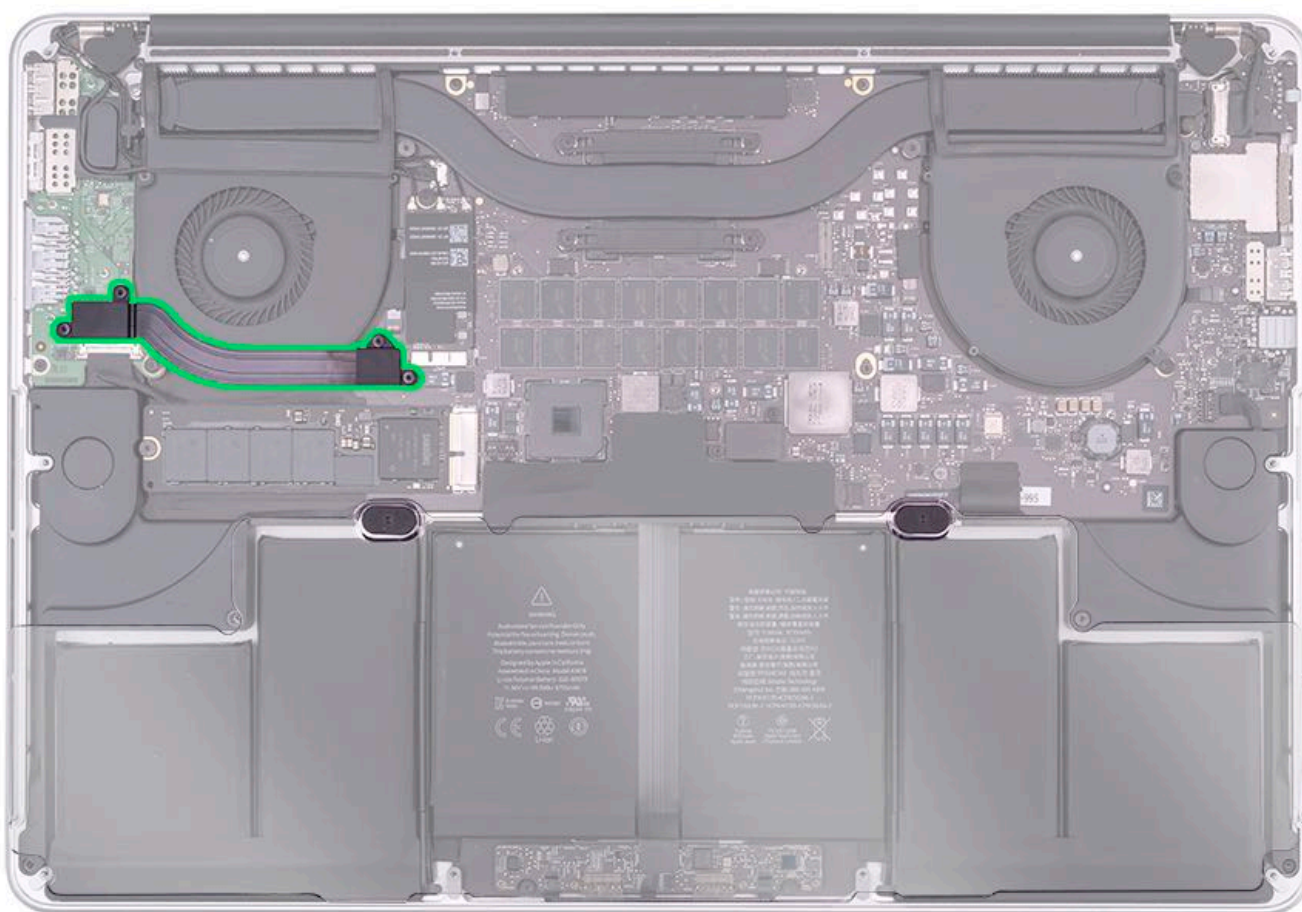
**Important:** This procedure should only be performed by Apple-certified technicians.

Remove:

- [Bottom Case](#)

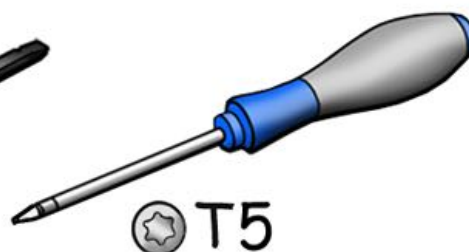


**Warning:** Always attach the [battery cover and disconnect the battery cable](#) immediately after removing the bottom case.



## Tools

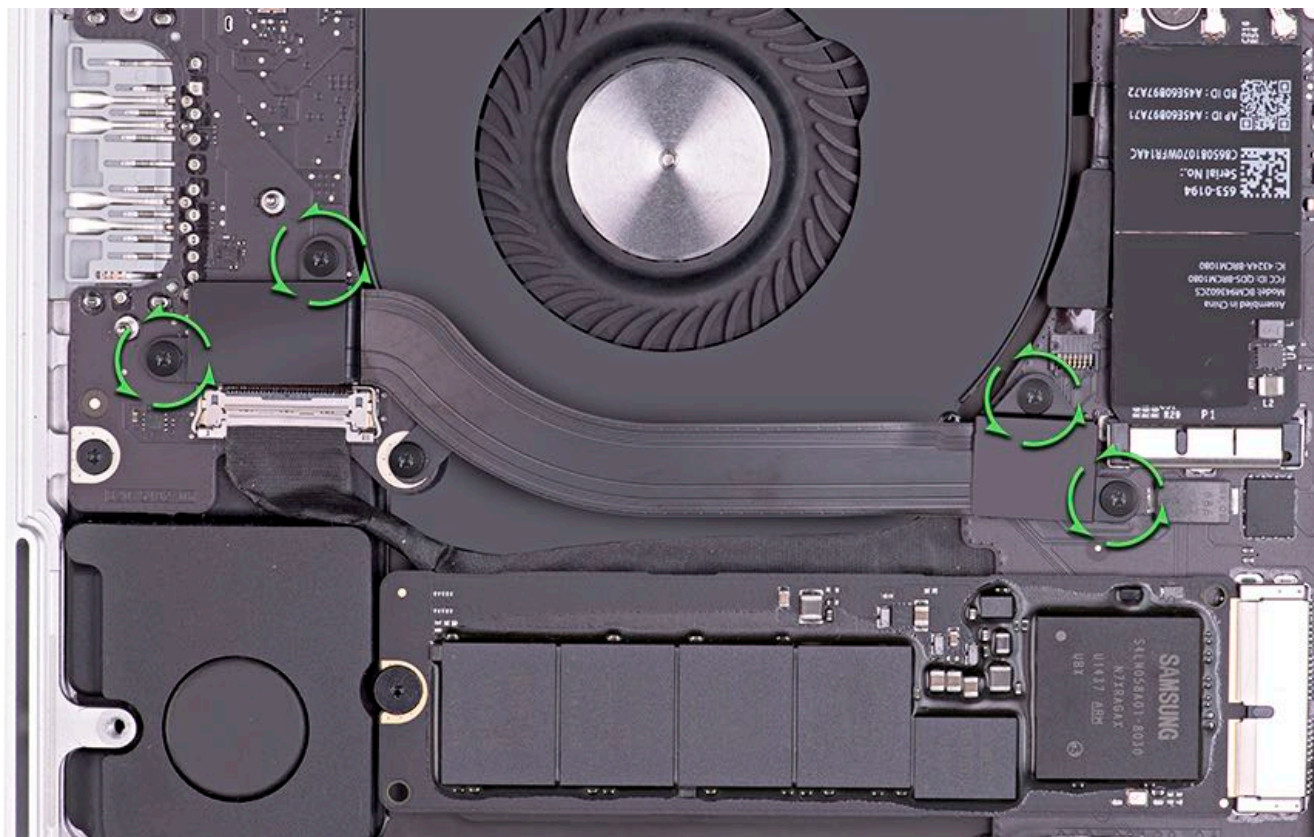
- ESD wrist strap
- Black stick
- Torx T5 screwdriver (magnetized)



## Steps For Removal

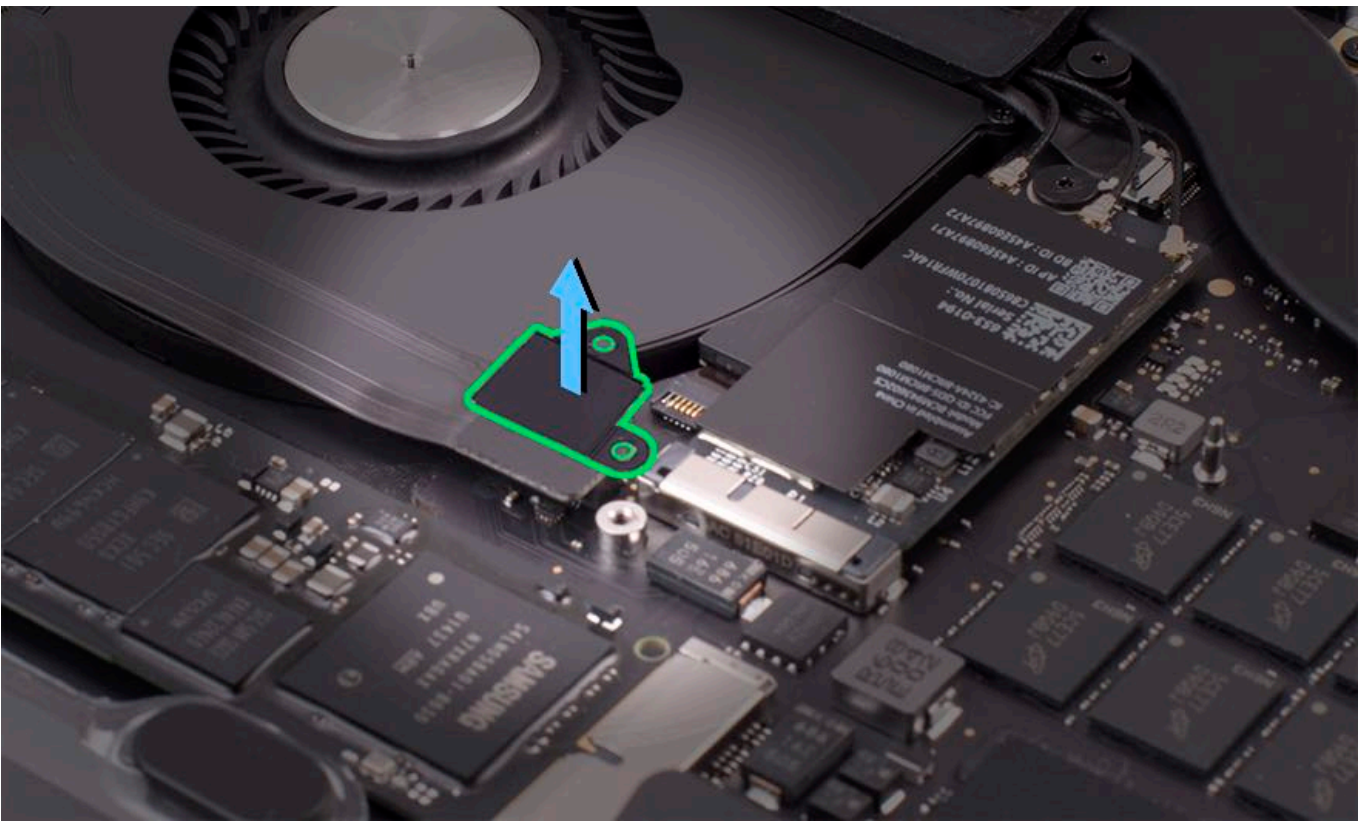
1. Remove the two T5 screws from the metal brackets on each end of the I/O flex cable.

- T5: 923-00523

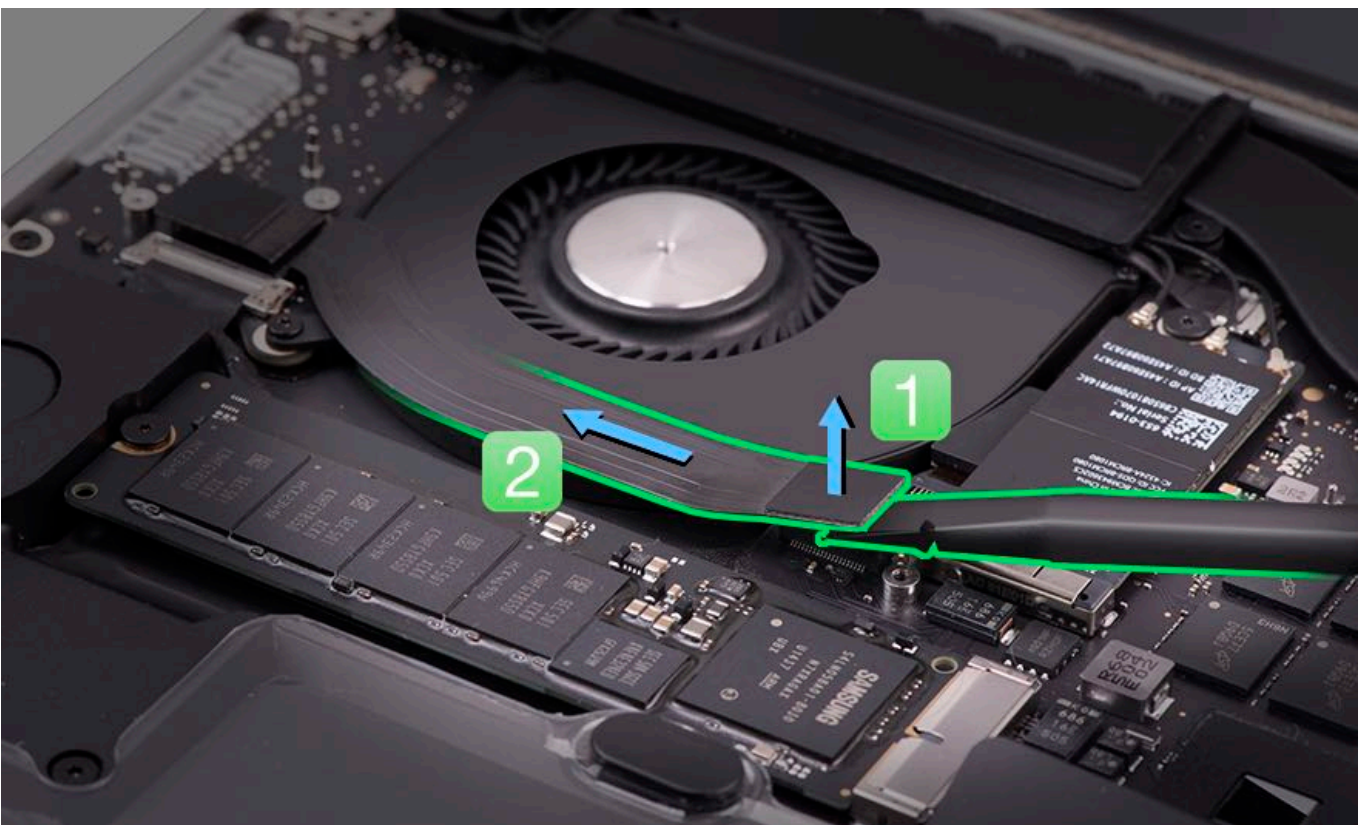


2. Remove the metal brackets and set them aside for reuse.

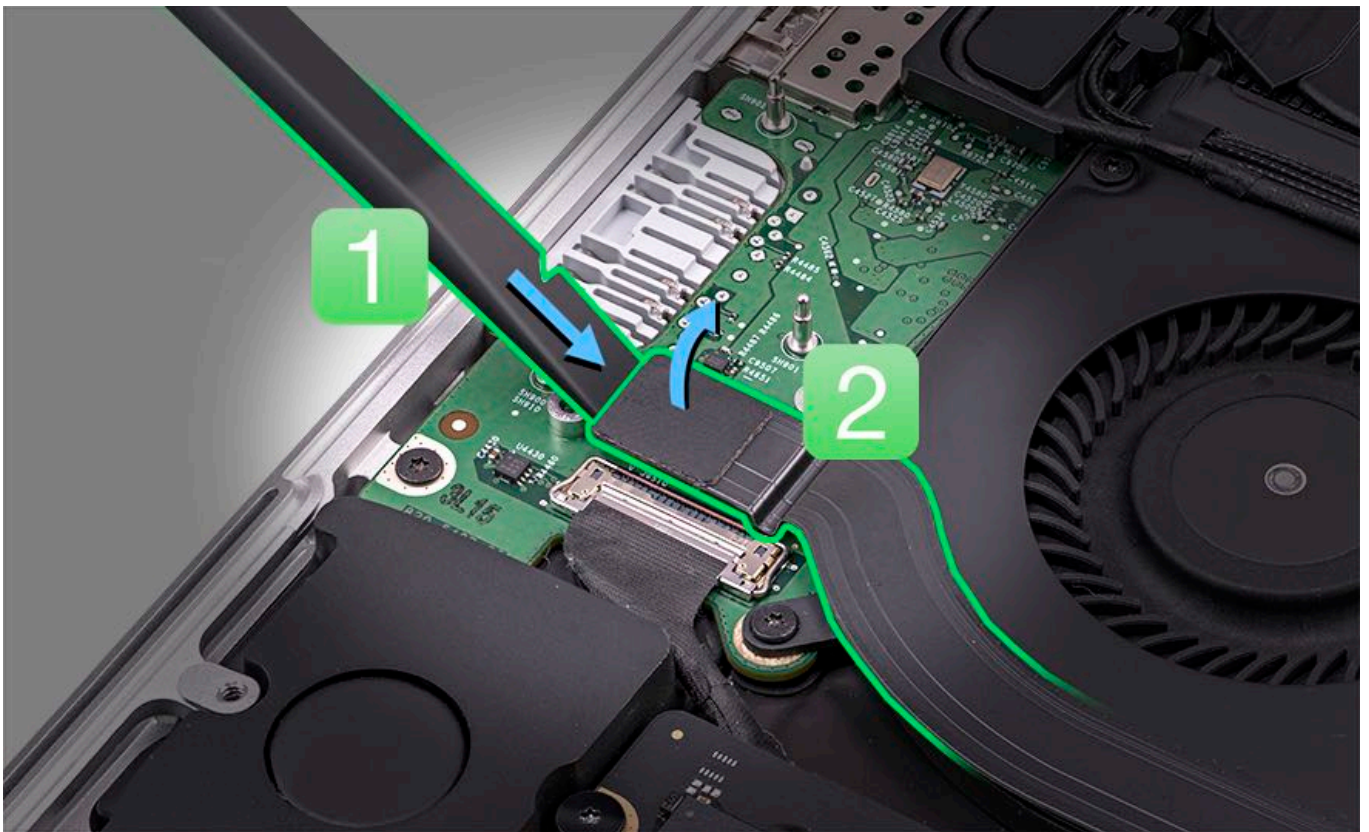




3. Use a black stick to lift the connector straight up (1). Then start at the logic board end and carefully peel the I/O flex cable from the fan in the direction of the I/O board (2).



4. Use a black stick (1) to disconnect the cable from the I/O board (2).



## Steps For Reassembly

### Notes:

- Remove the protective orange clip, which is used for shipping only, from the cable before installing.
  - Check for pin deformation on the logic and the I/O board connectors before installing the cable.
1. Connect the cable to the connectors on the logic board and the I/O board.
  2. Reinstall the connector cowl and reinstall the T5 screws.
  3. Trackpad performance must be validated after every repair.



# Right Fan

## First Steps

**Important:** This procedure should only be performed by Apple-certified technicians.

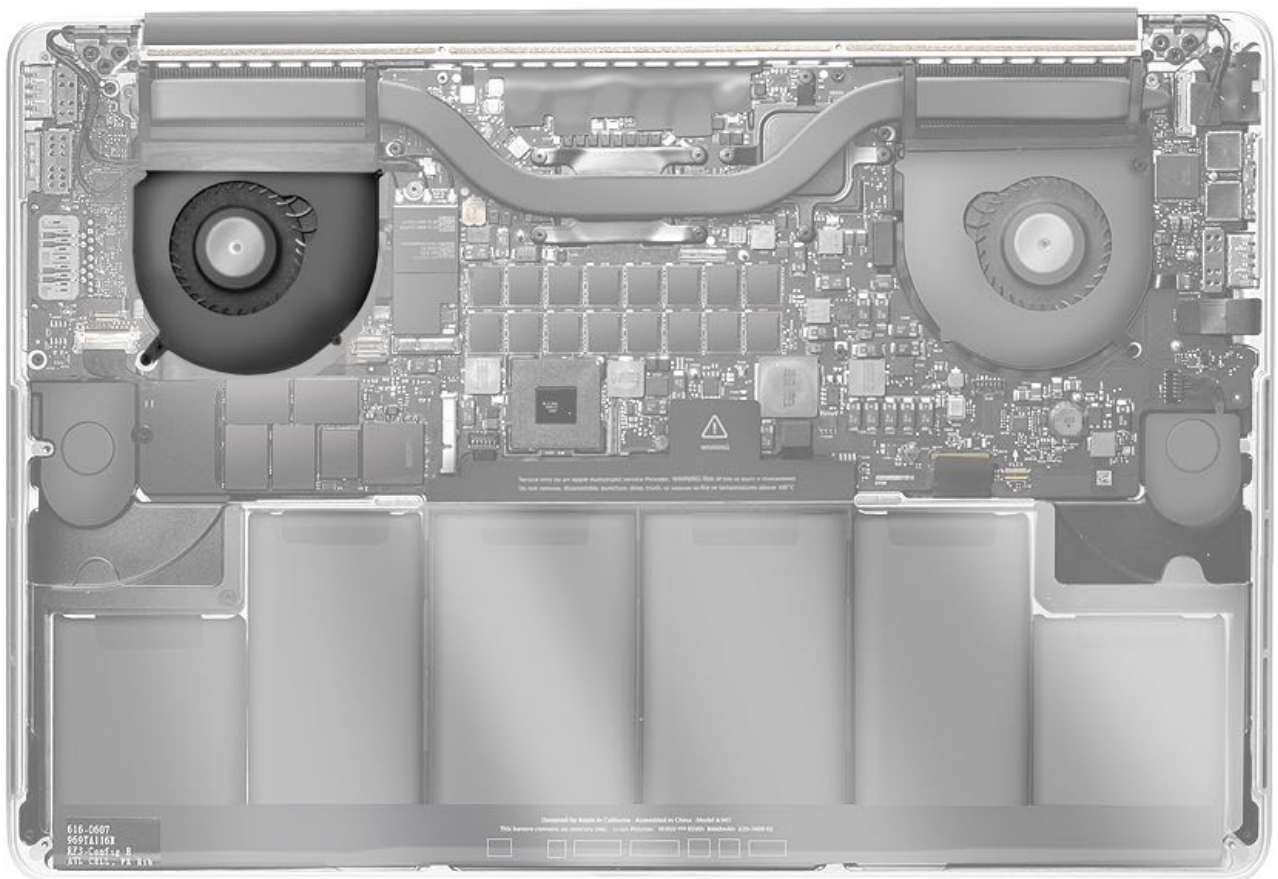
Remove:

- [Bottom case](#)
- [I/O flex cable](#)\* (Mid 2012 and Early 2013)
- [I/O flex cable](#)\* (Late 2013 and Mid 2014)
- [I/O flex cable](#) (Mid 2015)



**\*Note:** The adhesive on the underside of the I/O flex cable degrades each time the cable is lifted from the fan. If you are removing the right fan only to access other parts (I/O board and logic board for example), do not remove the flex cable from the fan. Instead, disconnect the two cable connectors and lift the fan with the cable attached.

**Warning:** Always [attach battery cover and disconnect battery cable](#) immediately after removing bottom case.



## Tools

- ESD wrist strap
- Black stick
- Torx T5 screwdriver (magnetized)



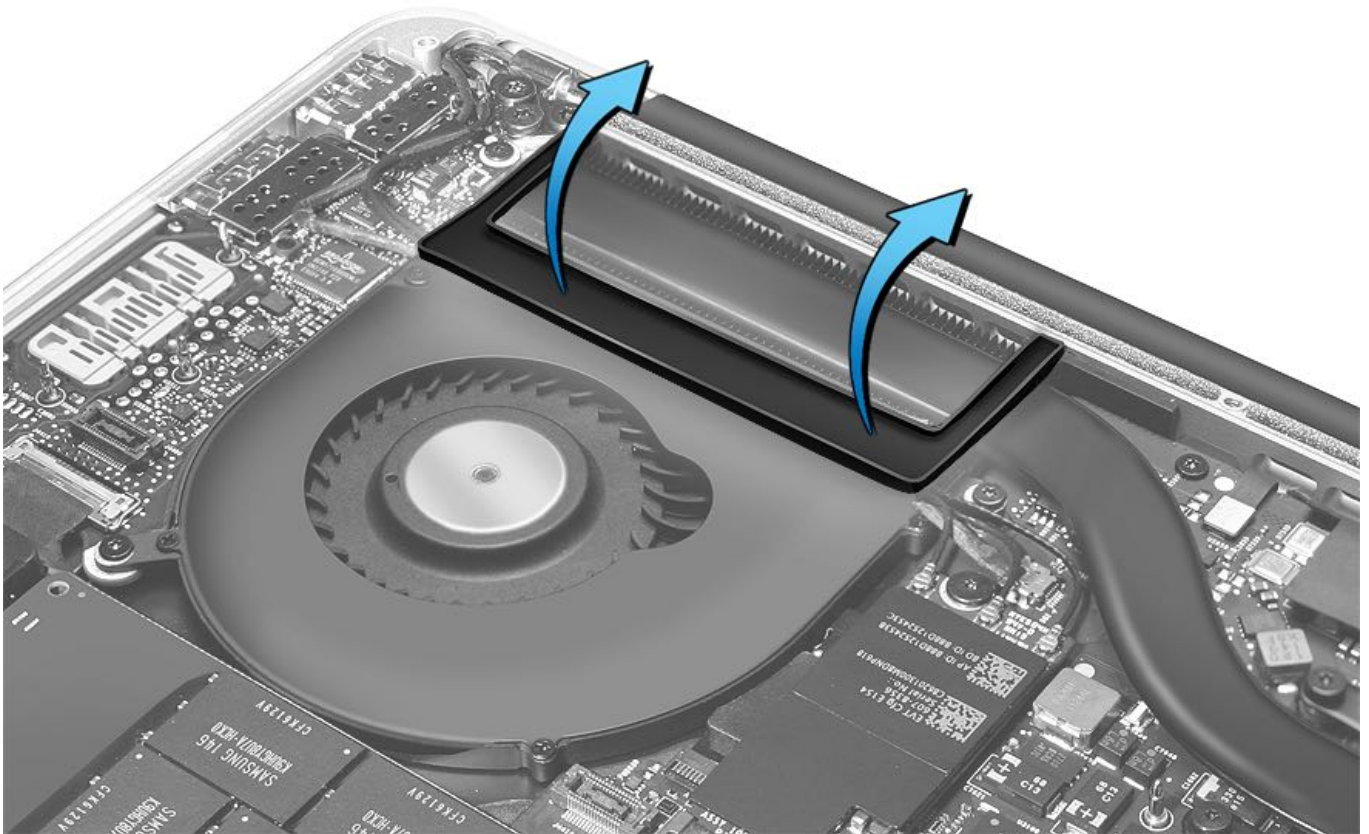
## Steps For Removal

**Note:** The right fan duct gasket and cable bundle are attached to the fan with adhesive. Use care when separating them from the fan.

**Important:** If the gasket is damaged or torn, the fan duct must be replaced, which requires removing the logic board.

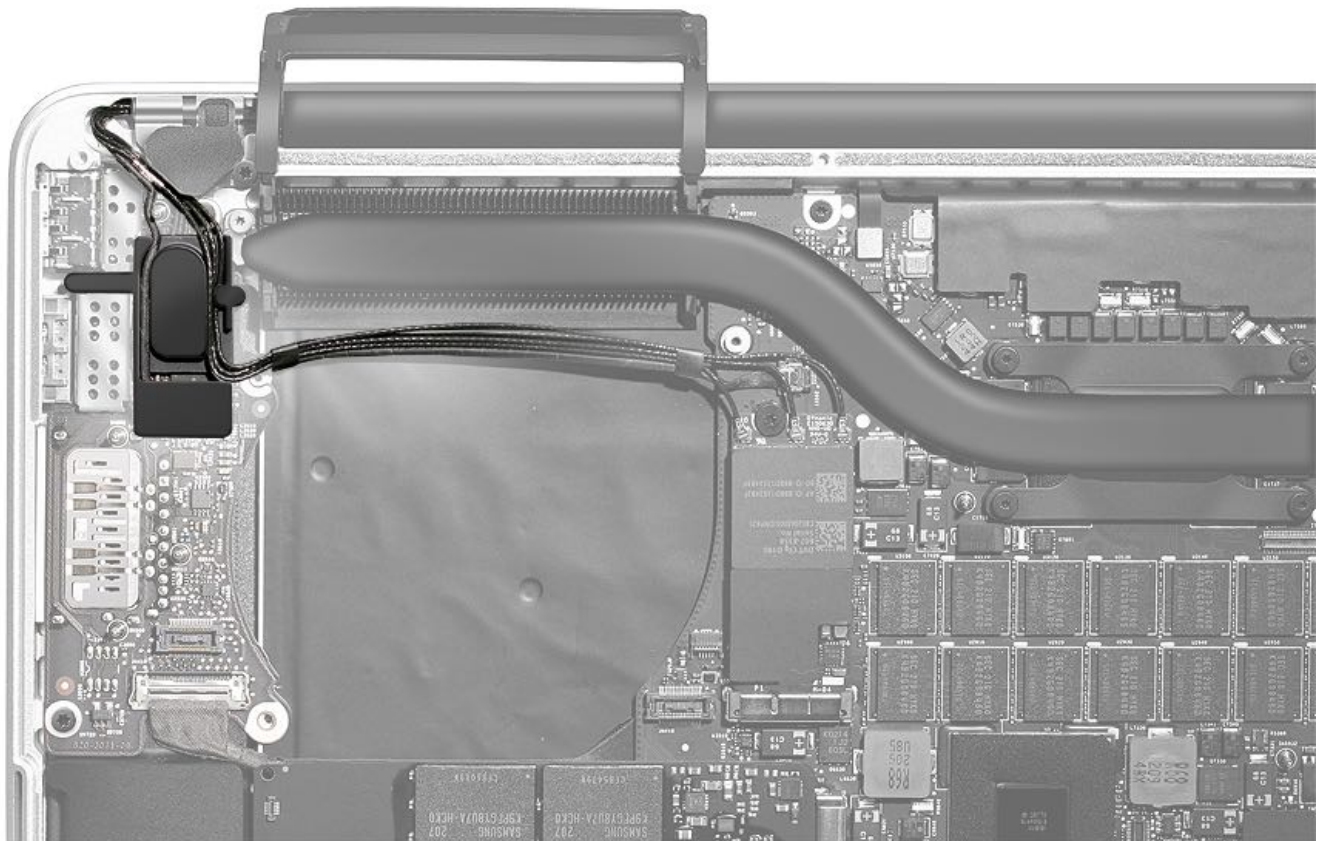
1. Use your fingers or a black stick to carefully separate the fan duct gasket from the fan and rotate the gasket out of the way.
2. Separate the cable bundle from the fan.

**Reassembly Note:** Be sure to return the gasket and cable bundle to the original position. Press down gently to adhere them to the fan.





**Reassembly Note:** Check that cables are properly rerouted into the I/O board cable guide as shown.



3. Remove three Torx mounting screws.

- One 923-0149 (short, top right)





- One 923-0133 (long, shoulder, top left)



- One 923-0162 (medium, bottom)

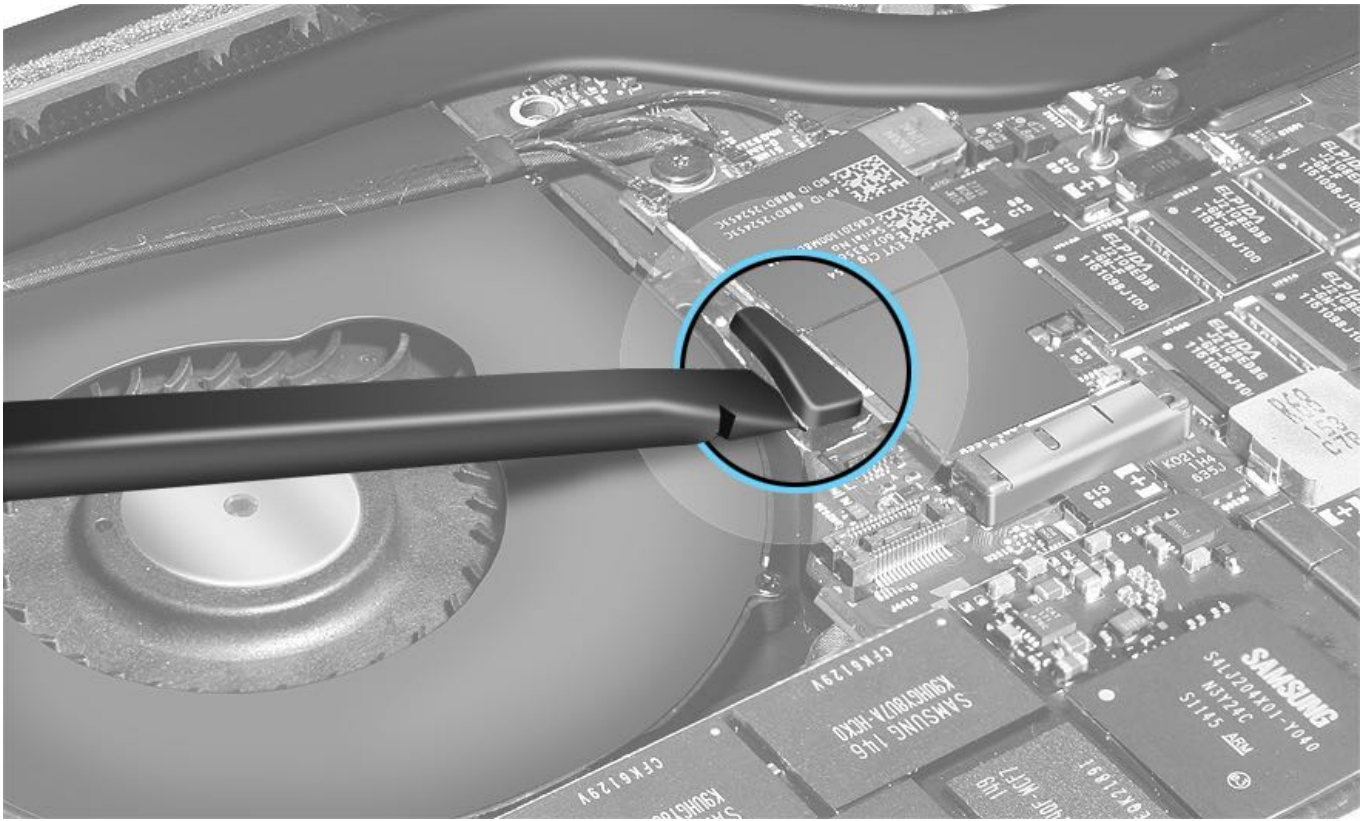


4. Lift the locking tab on the fan cable connector.

**Note:** The connector end of the fan cable is attached to the logic board with adhesive. Use care when lifting the cable from the logic board.

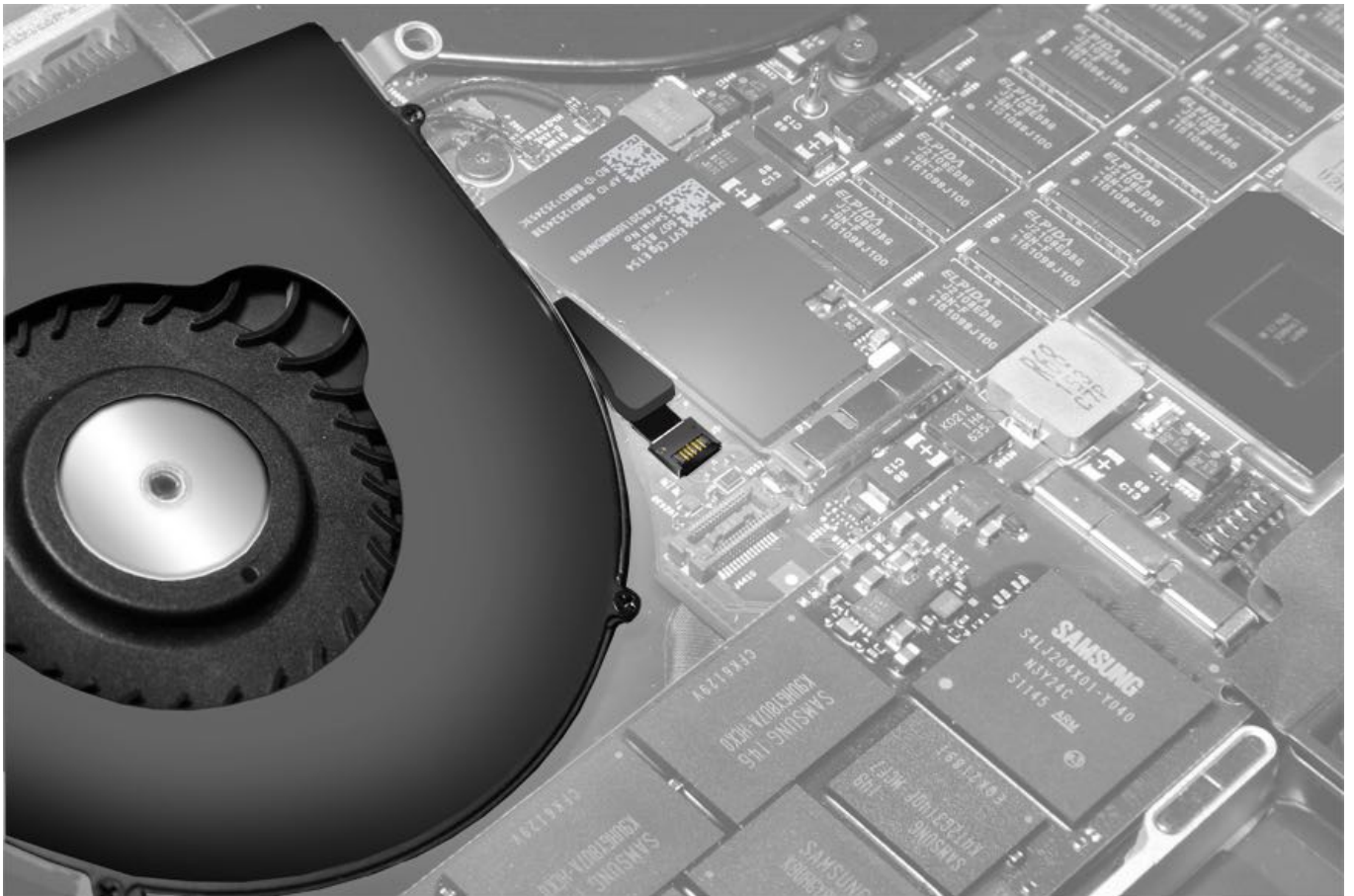
5. Use a black stick to carefully separate the cable from the logic board and disconnect the cable.





6. Slide the fan out from underneath the cable bundle and remove the fan from the top case.

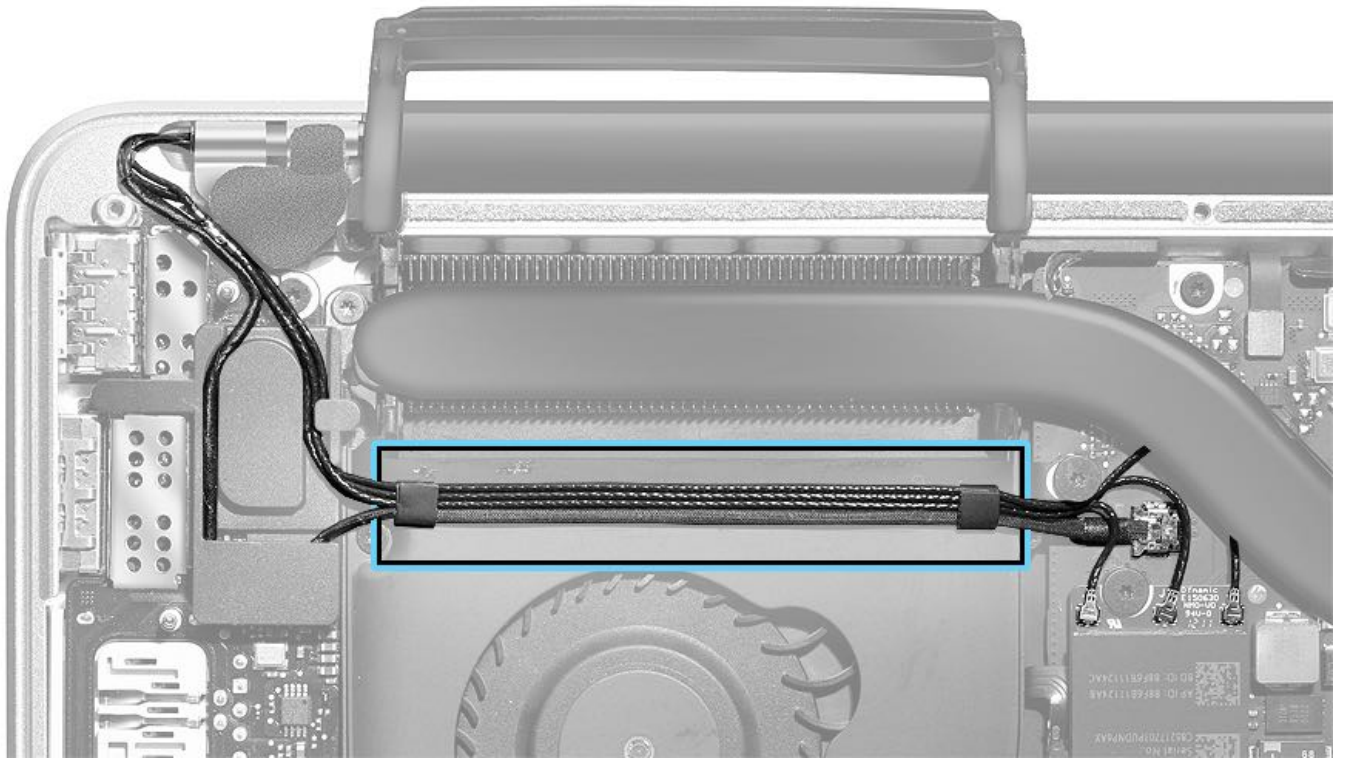
**Reassembly Note:** Connect the fan cable to the logic board before sliding the fan under the cable bundle. Make sure the fan cable is tucked under the wireless card and lies flat on the logic board.



## Steps For Reassembly

Reassemble in reverse order of removal steps.

**Reassembly Note:** To allow for easier fan access, you may choose to disconnect the camera and wireless card cables. After reinstalling the cables, make sure the cable bundle is flat.



**For MacBook Pro (Retina, 15-inch, Mid 2015) only:** Trackpad performance must be validated after every repair. For instructions, refer to article [TP1314: Trackpad Calibration Check](#).

# Left Fan

## First Steps

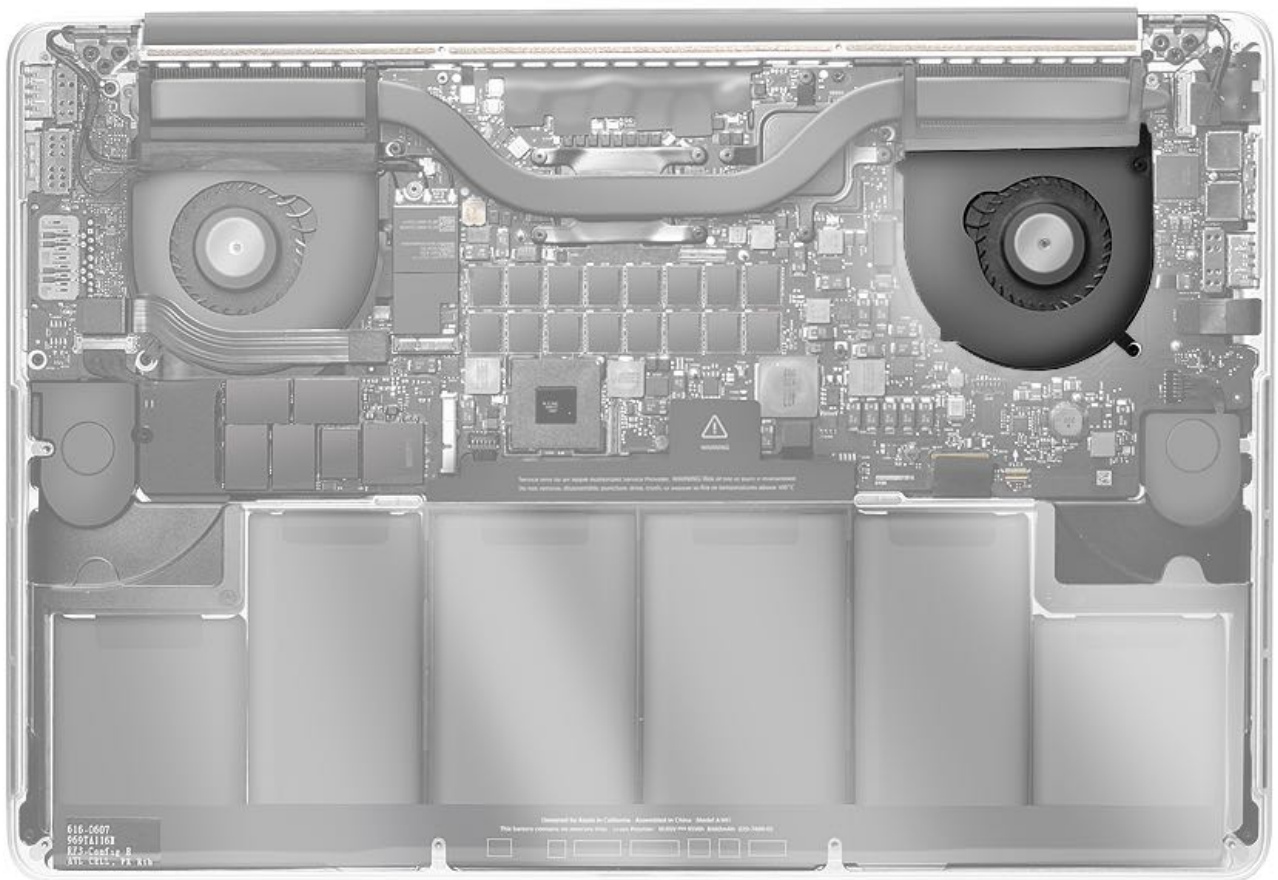
**Important:** This procedure should only be performed by Apple-certified technicians.

Remove:

- [Bottom case](#)

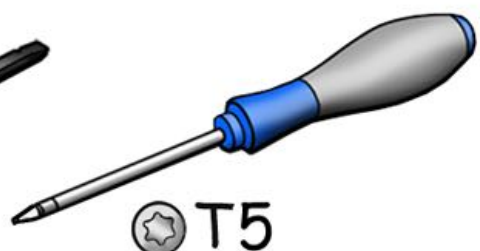


**Warning:** Always [attach the battery cover and disconnect the battery cable](#) immediately after removing the bottom case.



## Tools

- ESD wrist strap
- Black stick
- Torx T5 screwdriver (magnetized)



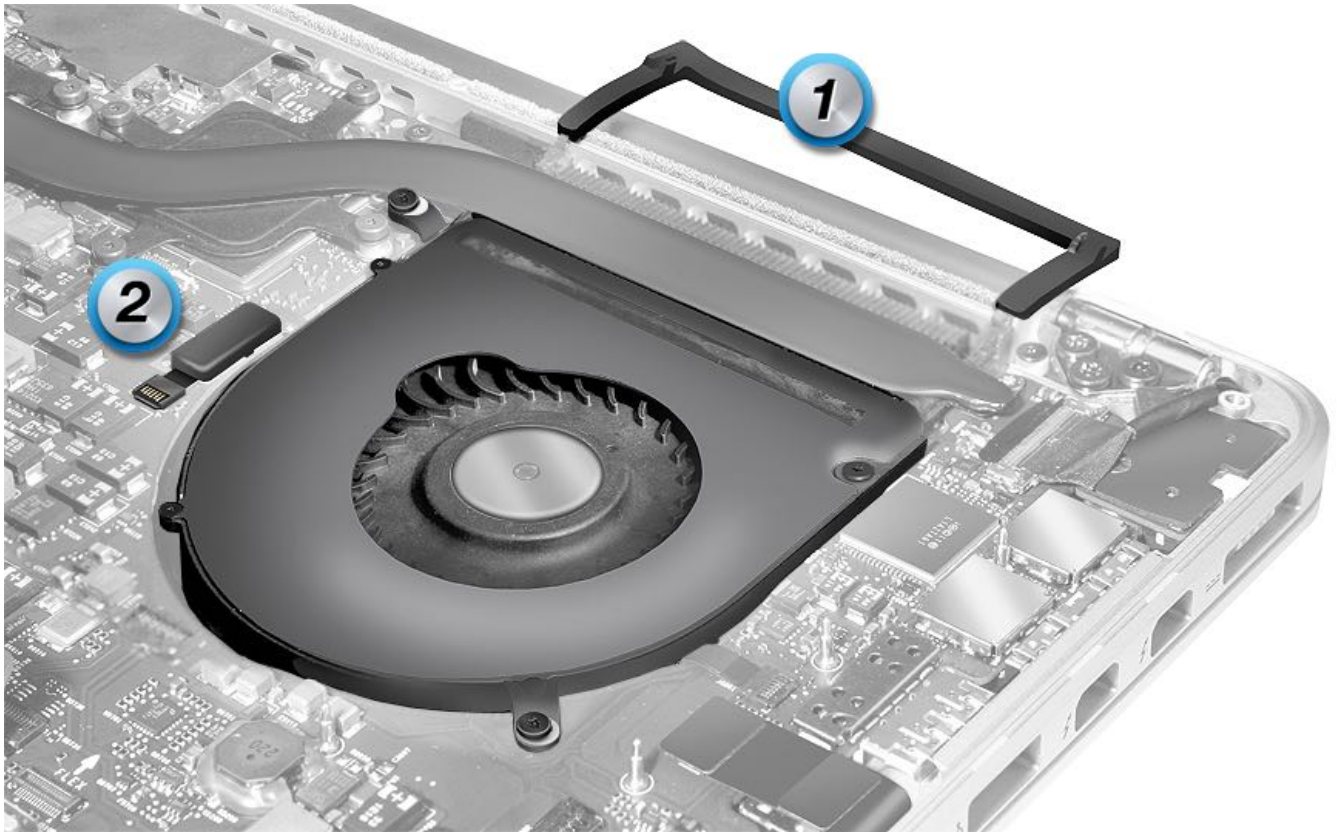


## Steps For Removal

**Important:** The left fan duct gasket is attached to the fan with adhesive. Use care when separating the gasket from the fan. If the gasket is damaged or torn, the fan duct must be replaced, which requires removing the logic board.

1. Using your fingers or a black stick, carefully lift the fan duct gasket from the fan and rotate the gasket out of the way.

**Reassembly Note:** Be sure to return the gasket to the original position. Press down gently to adhere the gasket to the fan.



2. Lift the locking tab on the fan cable connector and disconnect the cable from the logic board.

3. Remove three T5 screws and lift the fan from the case.

- One 923-0158 (short, thin head, top left)



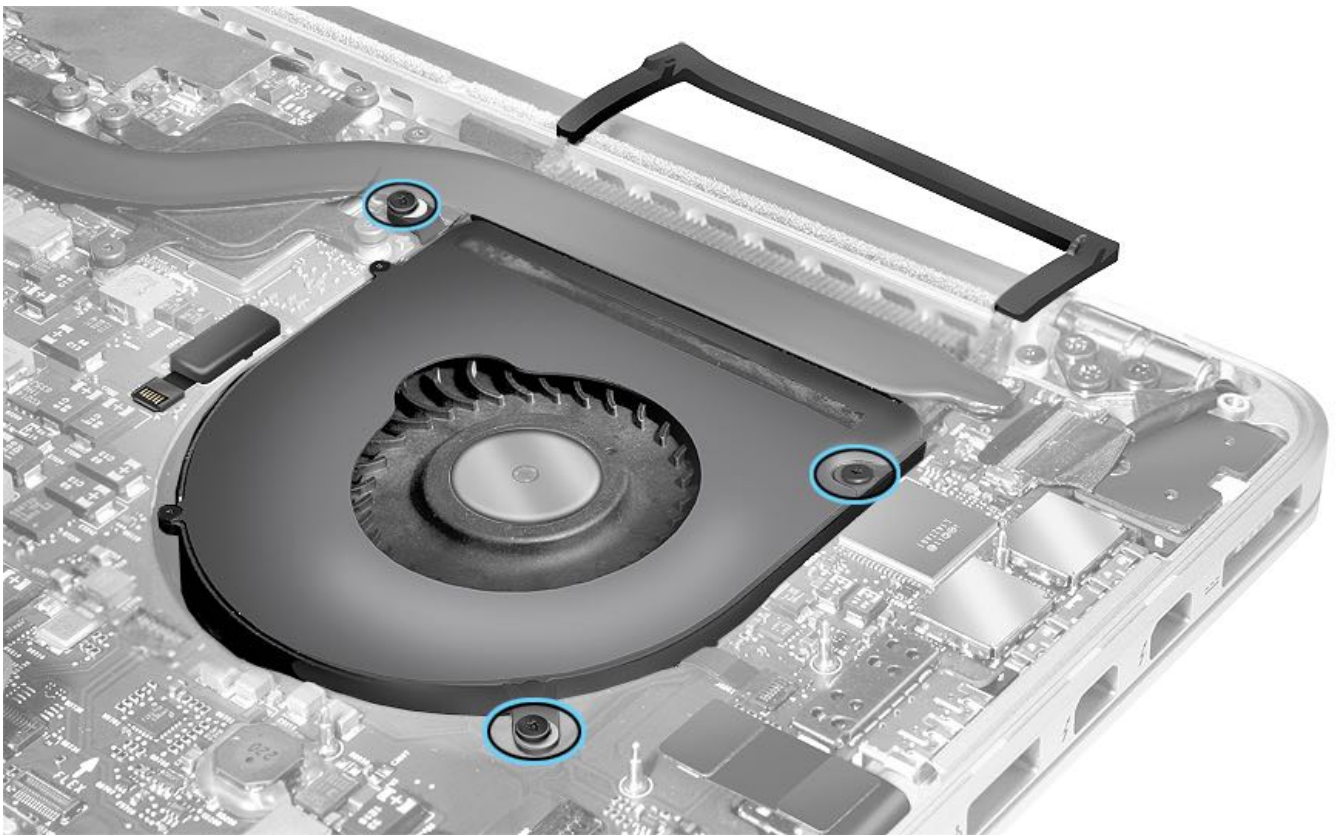
- One 923-0133 (long, shoulder, top right)



- One 923-0162 (medium, bottom)







### Steps For Reassembly

Reassemble in reverse order of removal steps.

**For MacBook Pro (Retina, 15-inch, Early 2015) only:** Trackpad performance must be validated after every repair.

# Input/Output (I/O) Board

## First Steps

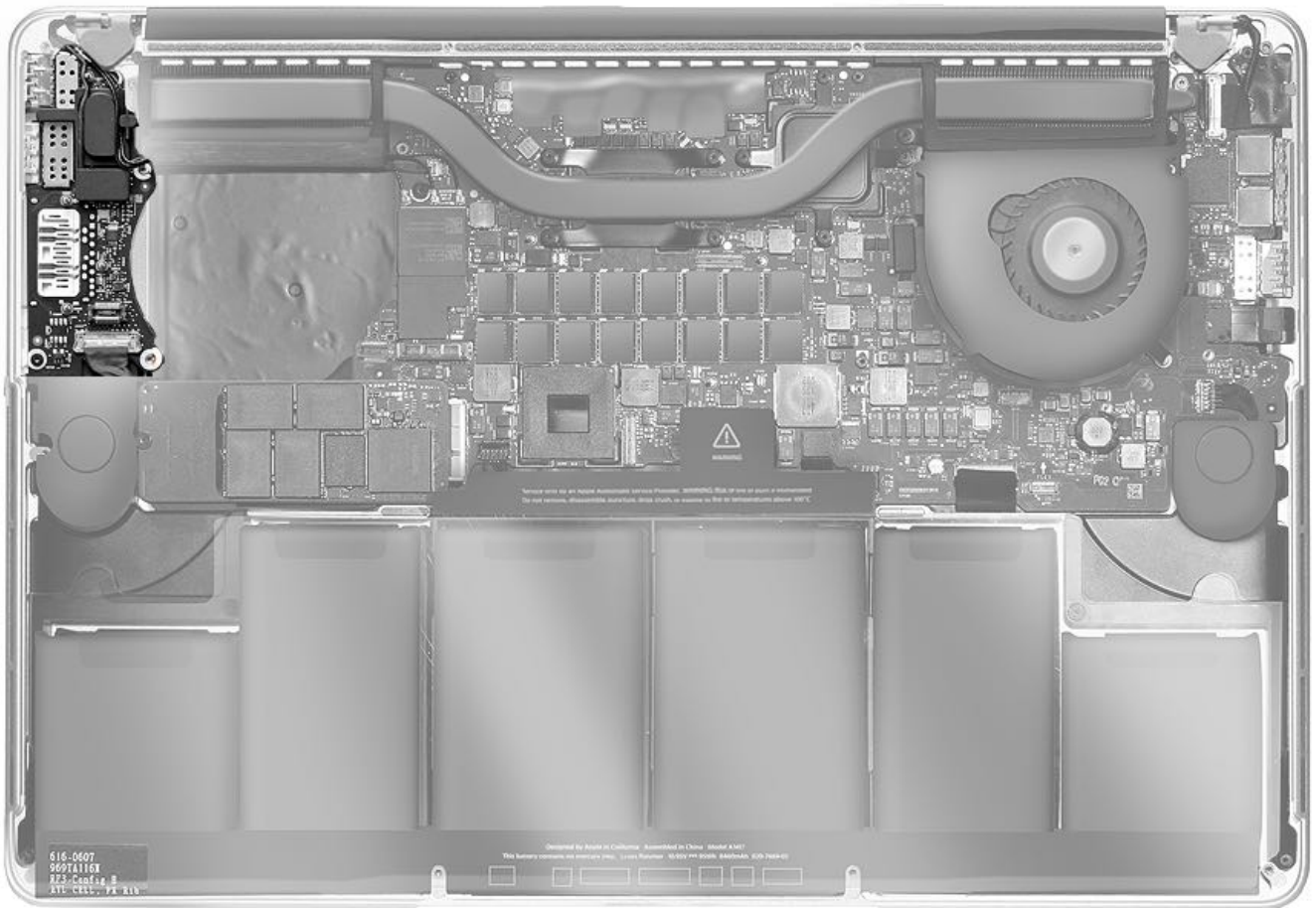
**Important:** This procedure should only be performed by Apple-certified technicians.

Remove:

- [Bottom case](#)
- [I/O flex cable](#) (Mid 2012 and Early 2013)
- [I/O flex cable](#) (Late 2013 and Mid 2014)
- [I/O flex cable](#) (Mid 2015)
- [Right fan](#)



**Warning:** Always [attach the battery cover and disconnect the battery cable](#) immediately after removing the bottom case.



## Tools

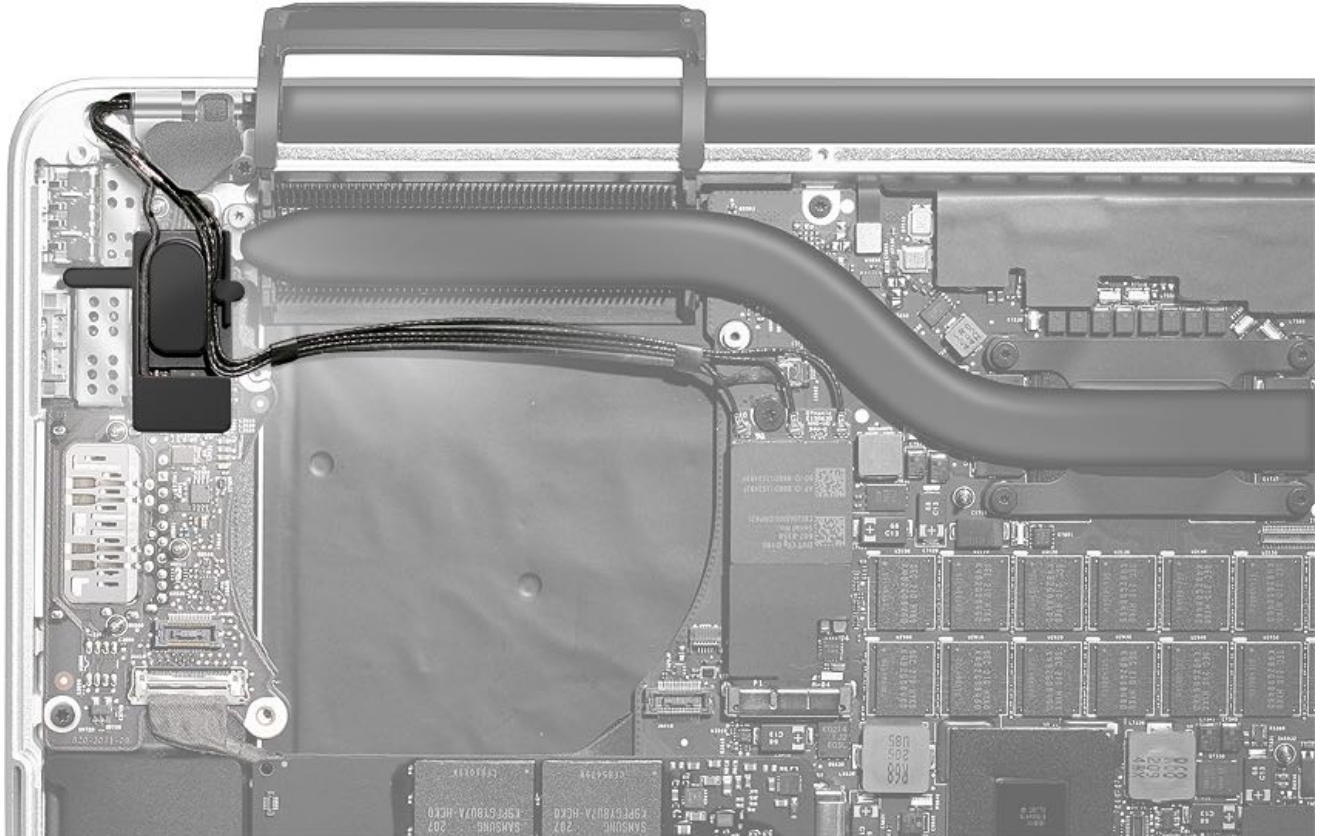
- ESD wrist strap
- Black stick
- Torx T5 screwdriver (magnetized)



## Steps For Removal

1. Remove the cables from the I/O board cable guide.

**Reassembly Note:** Reroute the cables in the guide as shown.

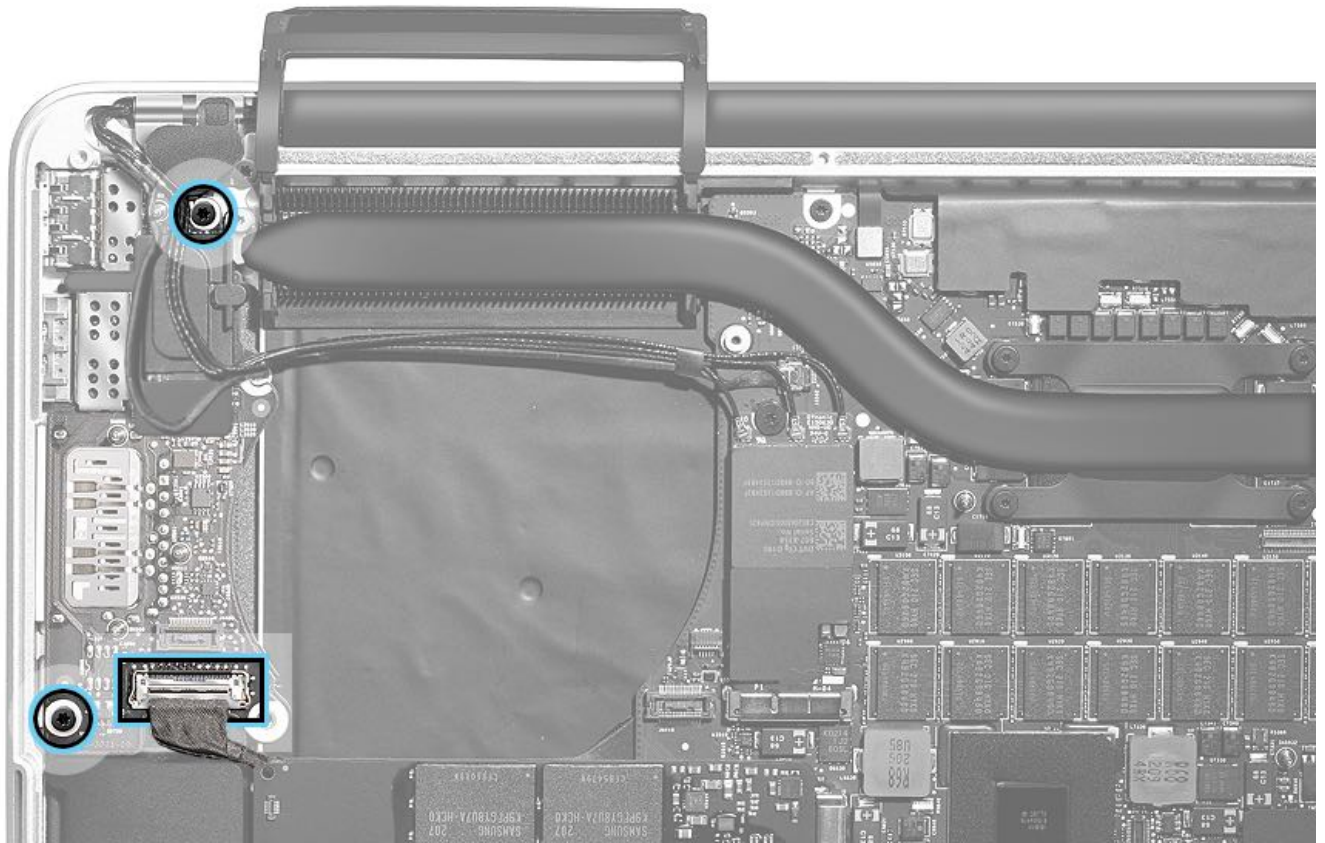


2. Lift the locking tab on the I/O coax cable connector and disconnect the cable from the I/O board.
3. Remove two I/O board mounting screws.

- Two 923-0135 (2.6 mm)



4. Slide the board to the right a short distance until the ports clear the openings in the top case, then remove the board from the case.



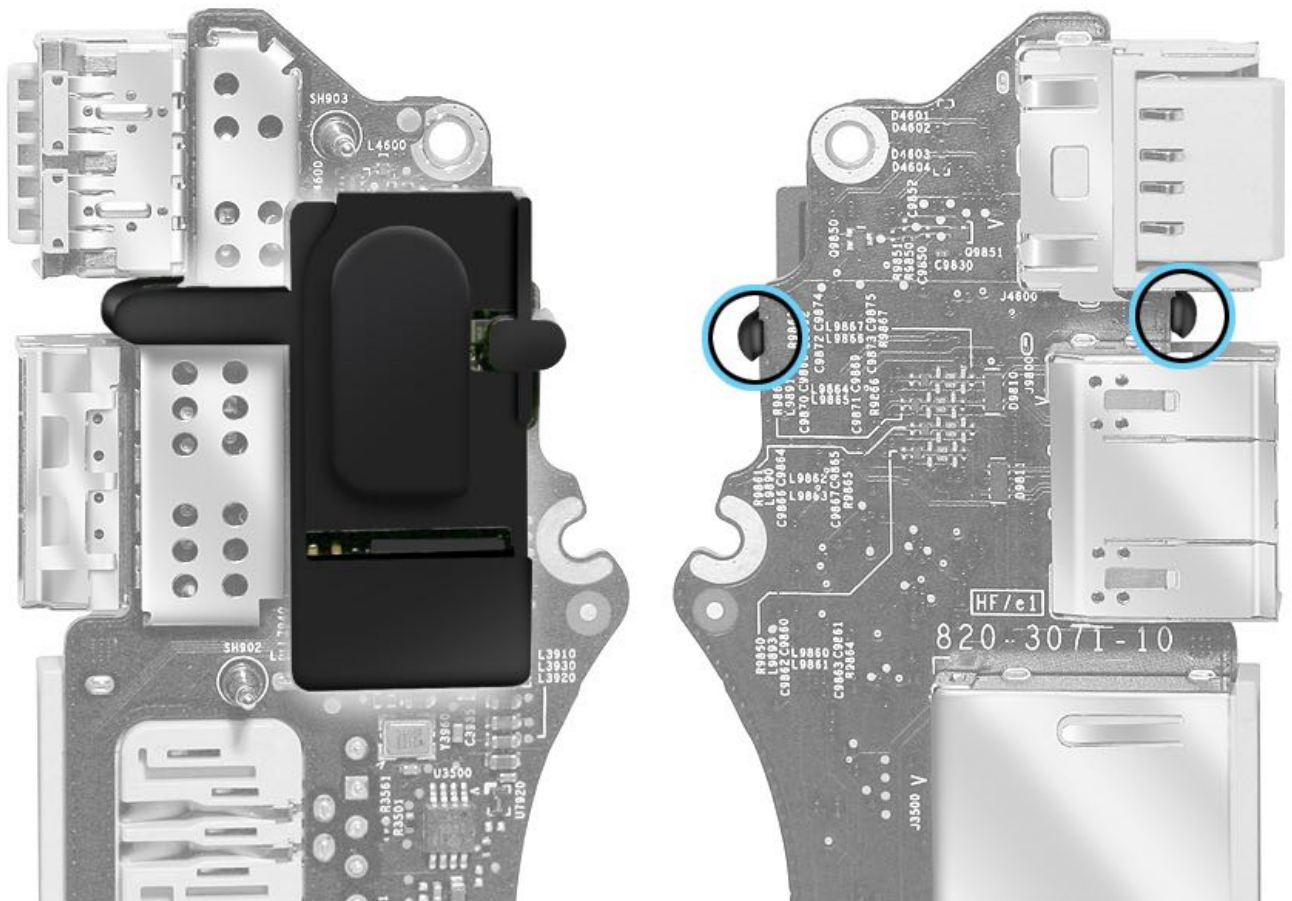
## Steps For Reassembly

Reassemble in reverse order of removal steps.

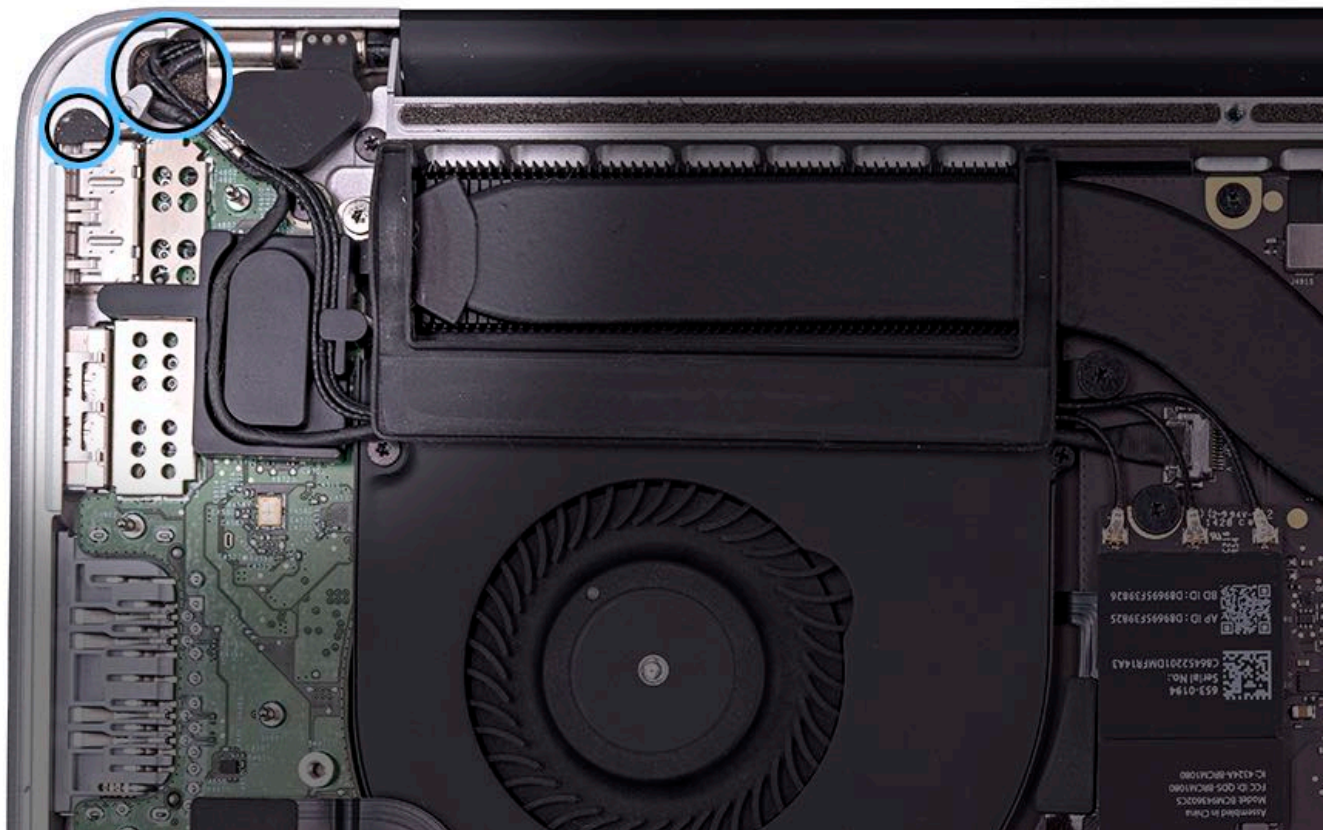
**Caution:** When installing the board, use caution at the ports to prevent damage to metal EMI ground tabs. Make sure the ground tabs fit **under** the lip of the top case.

**Note:** Replacement I/O boards do not come with the cable guide. If you are installing a replacement I/O board, you must transfer the guide to the replacement board. To remove the guide, remove the I/O board and unclip the guide from the board. Replacement cable guides are also available as a separate service part (923-0110).





**For MacBook Pro (Retina, Mid 2015) only:** Check that the two foam gaskets are present in the top case before installing the I/O board.



**For MacBook Pro (Retina, 15-inch, Mid 2015) only:** Trackpad performance must be validated after every repair.

# Logic Board

## First Steps

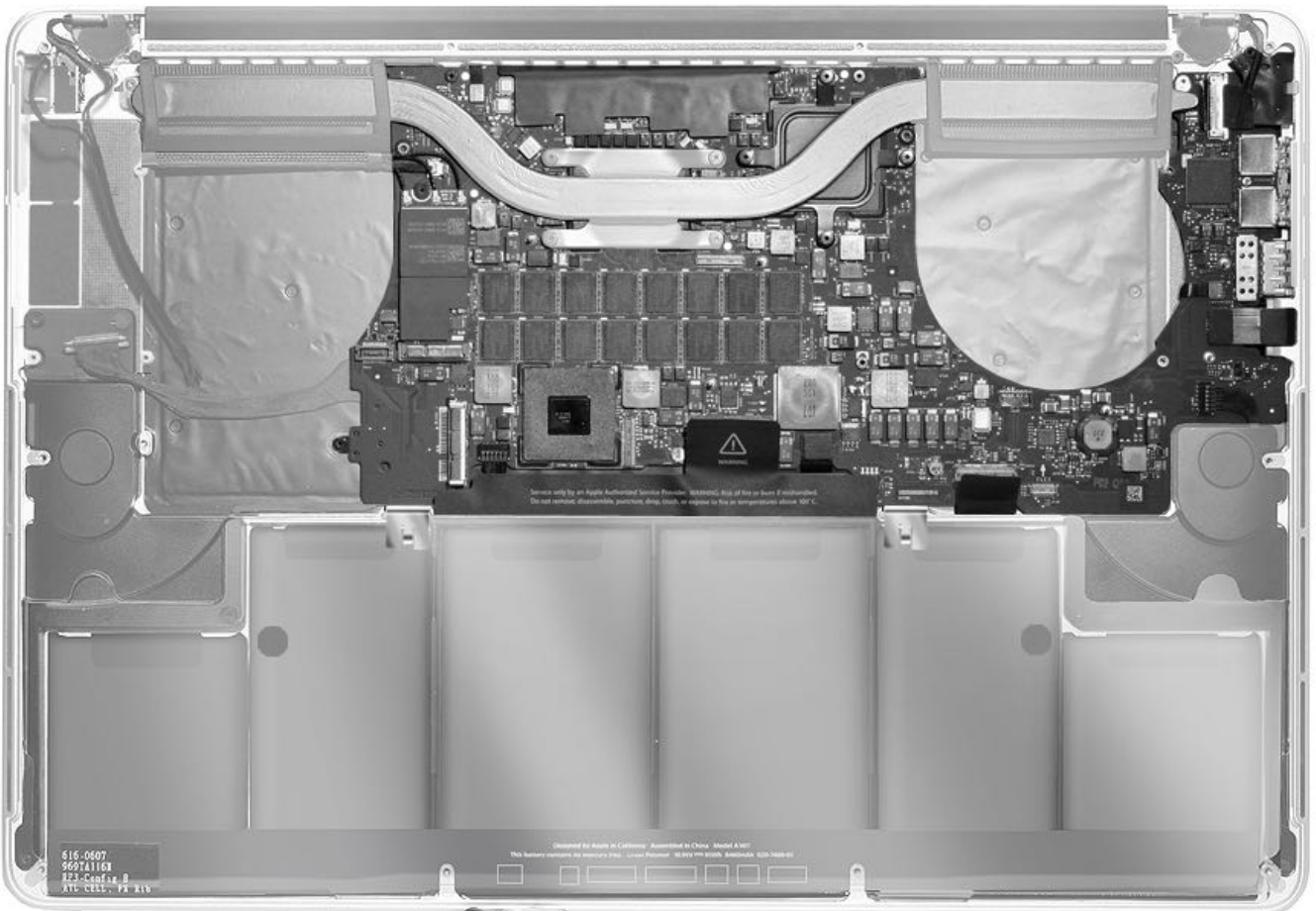
**Important:** This procedure should only be performed by Apple-certified technicians.

Remove:

- [Bottom case](#)
- [SSD card or flash storage](#)
- [I/O flex cable](#) (Mid 2012 and Early 2013)
- [I/O flex cable](#) (Late 2013 and Mid 2014)
- [I/O flex cable](#) (Mid 2015)
- [Right fan](#)
- [Left fan](#)
- [I/O board](#)



**Warning:** Always [attach the battery cover and disconnect the battery cable](#) immediately after removing the bottom case.



## Tools

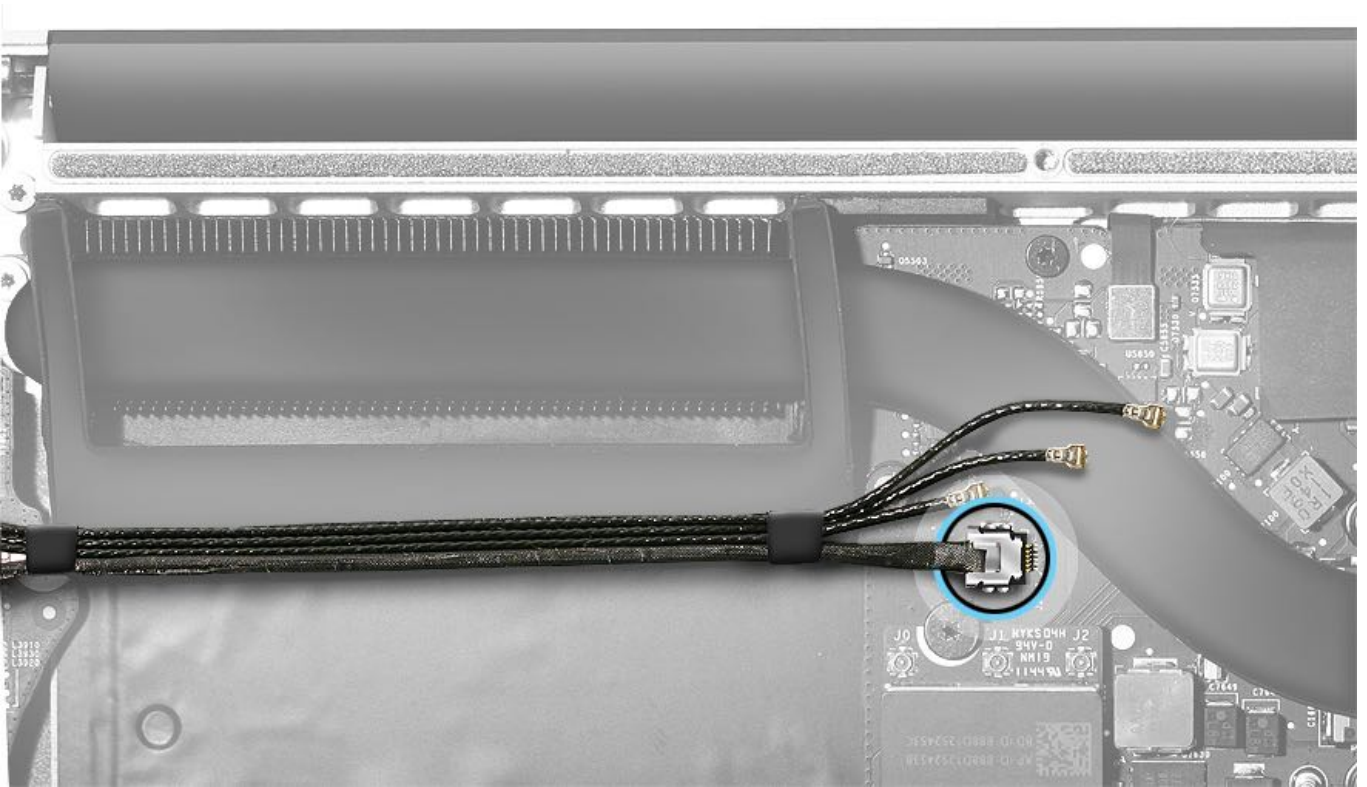
- ESD wrist strap
- Torx T5 screwdriver (magnetized)
- Black stick



- 

2. Disconnect the camera cable from the logic board and move the cable bundle out of the way.





3. Flip up the lock bar and disconnect the eDP cable from the logic board.



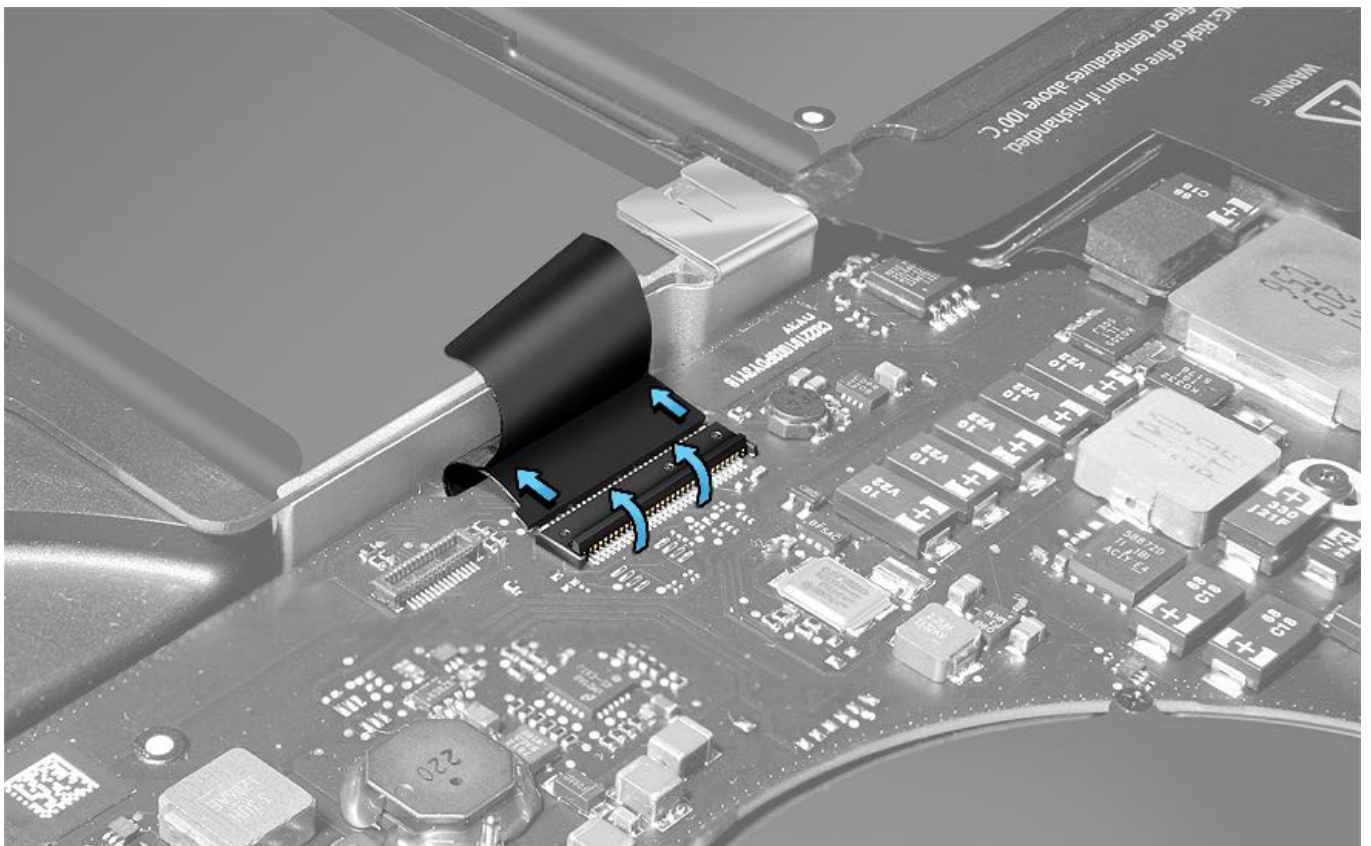
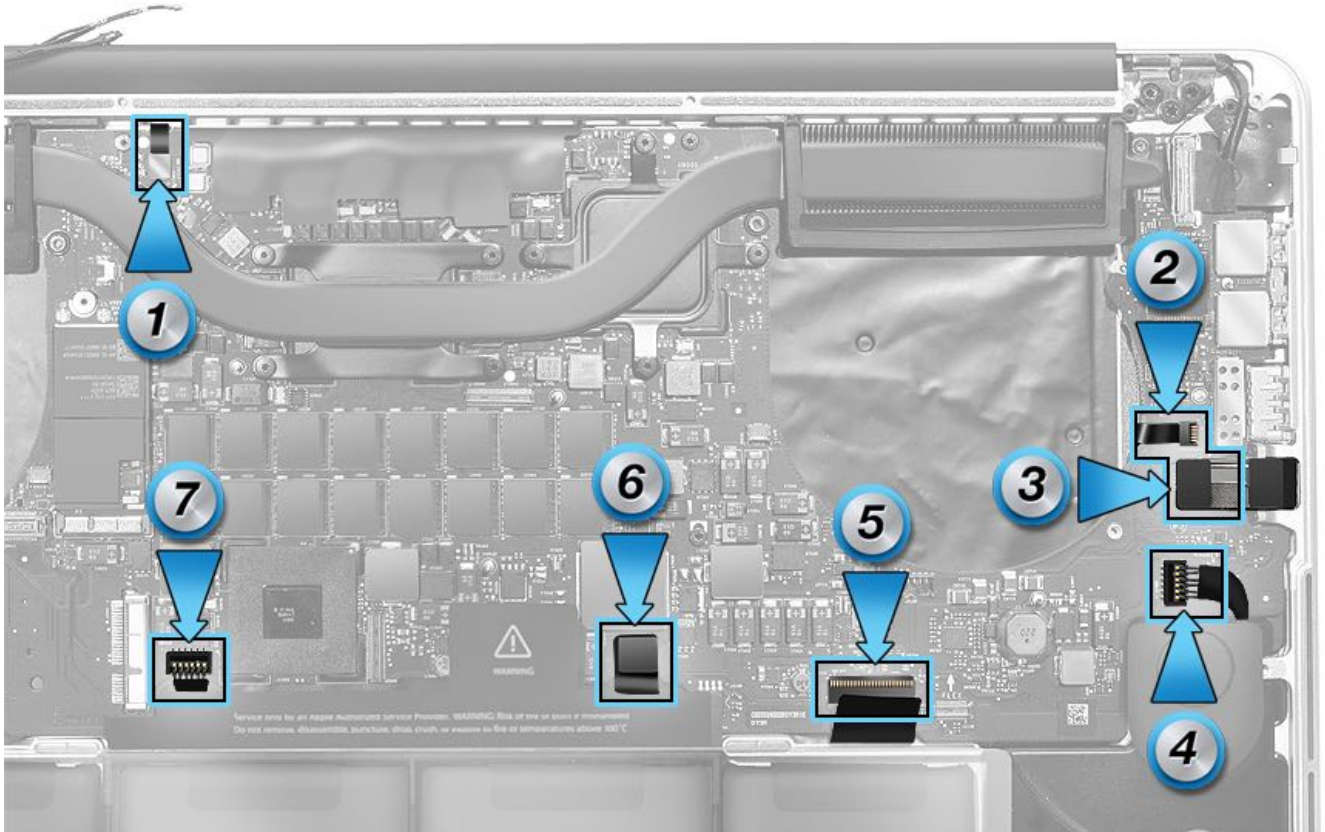
4. Disconnect the remaining seven cables from the logic board. Use Kapton tape to set aside the cables as you disconnect them.

1. **Keyboard backlight** - low-profile solid platform flex
2. **Microphone** - locking lever
3. **Audio board** - low-profile solid platform flex (Mid 2012 and Early 2013 only)
4. **Left speaker** - vertical insertion
5. **Keyboard/power-on button\*** - locking lever
6. **Trackpad** - low-profile solid platform flex (**Note for MacBook Pro (Retina, 15-inch, Mid 2015):** The trackpad cable includes a metal bracket that is held in place with two T5 screws)
7. **Right speaker** - vertical insertion

**\*Note:** You will need to peel back the cover on the keyboard/power-on button cable to access the connector.

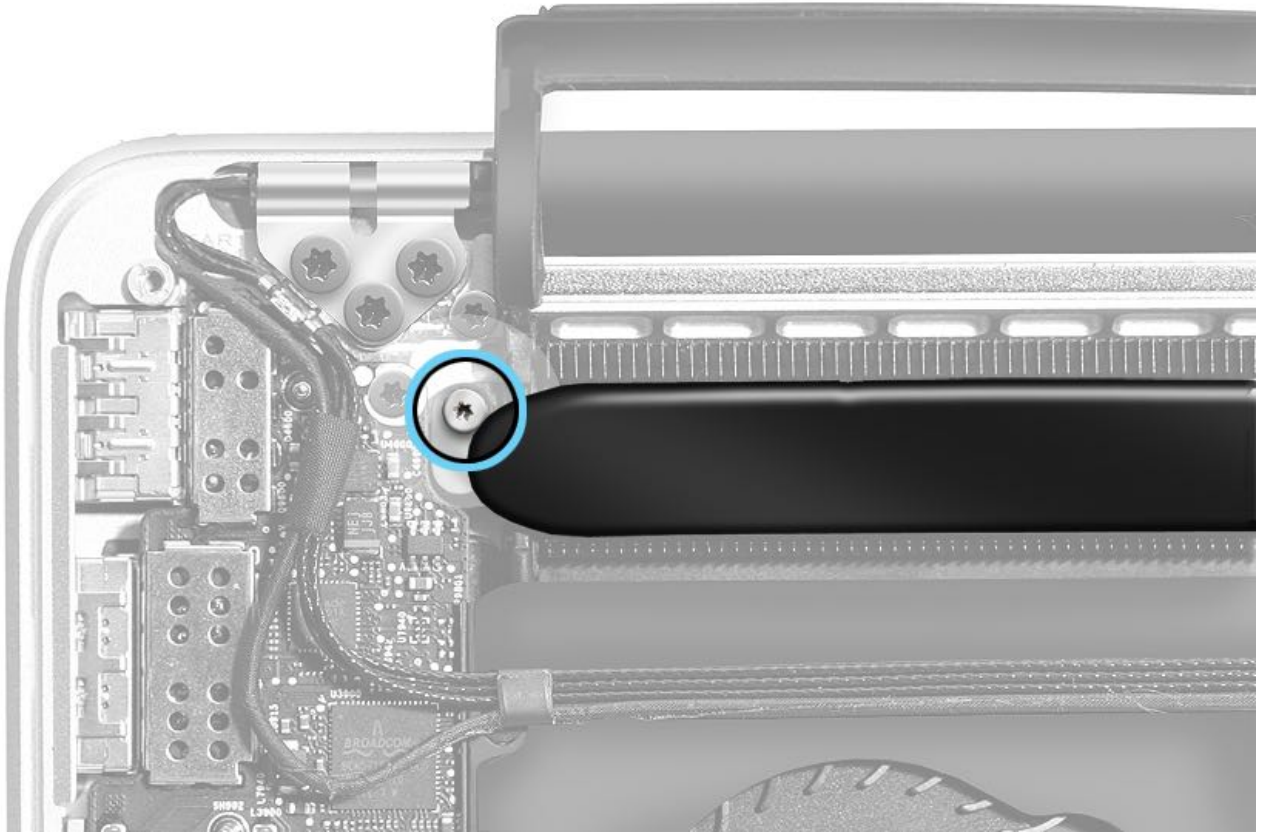


**Caution:** The fan connectors and locking levers at cable connectors 2 and 5 are fragile. To protect the levers during handling or shipment of the logic board, close the levers after the cables are removed. Once the logic board is installed in the top case and the cables are connected, be sure to lock down the levers again.



5. Remove one Torx T5 screw from the right end of the heat sink.

- 923-0148 (2.95 mm)

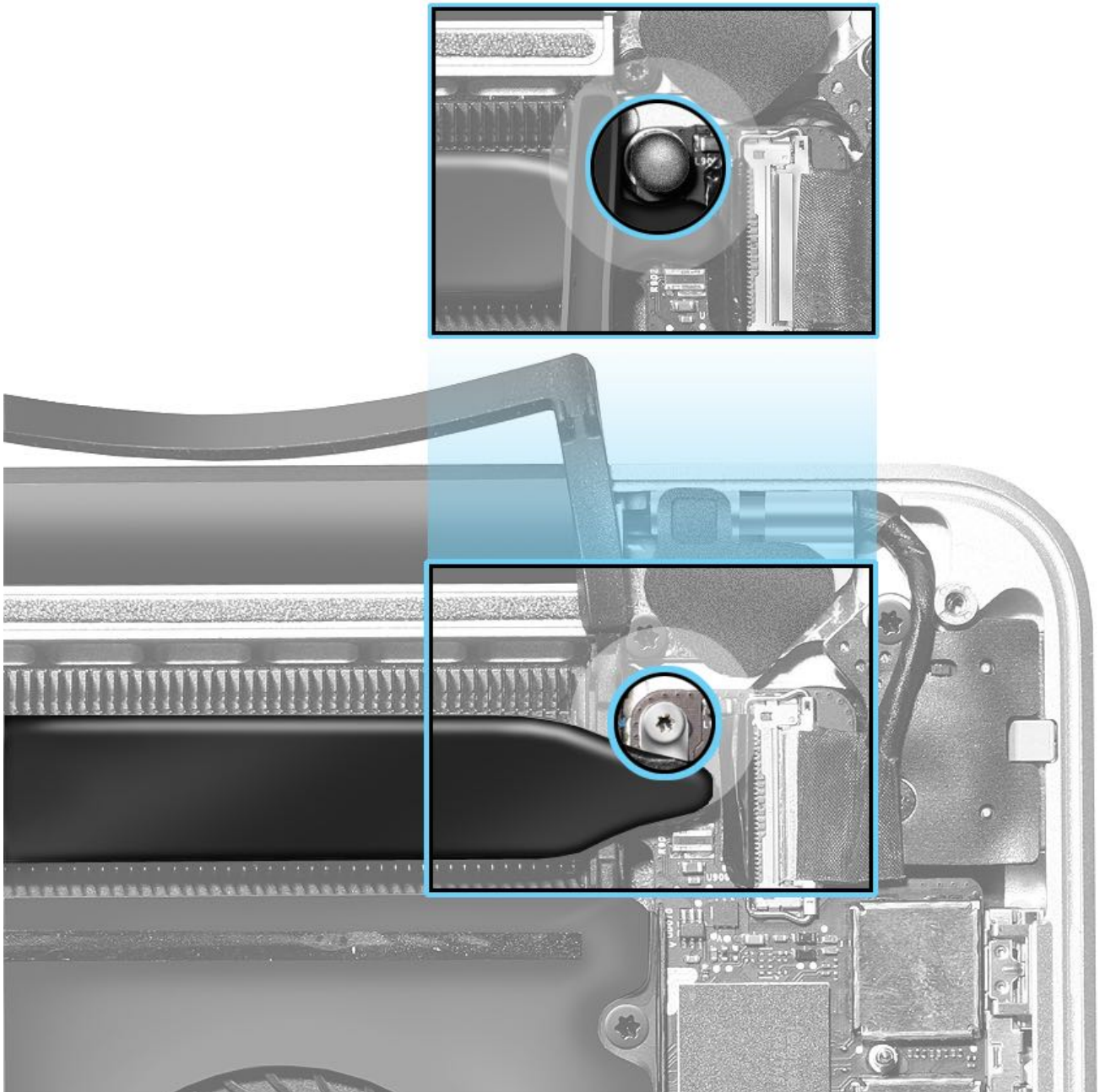


6. Remove the ground cap and one Torx T5 screw from the left end of heat sink.

- One 923-0147 (3.6 mm)



**Reassembly Note:** Retain the ground cap and replace it after reinstalling the screw. The ground cap is also available as part 923-0111.



7. Remove the remaining four Torx T5 screws:

- #1 and #2 screws  
Two 923-0145 (4.95 mm)

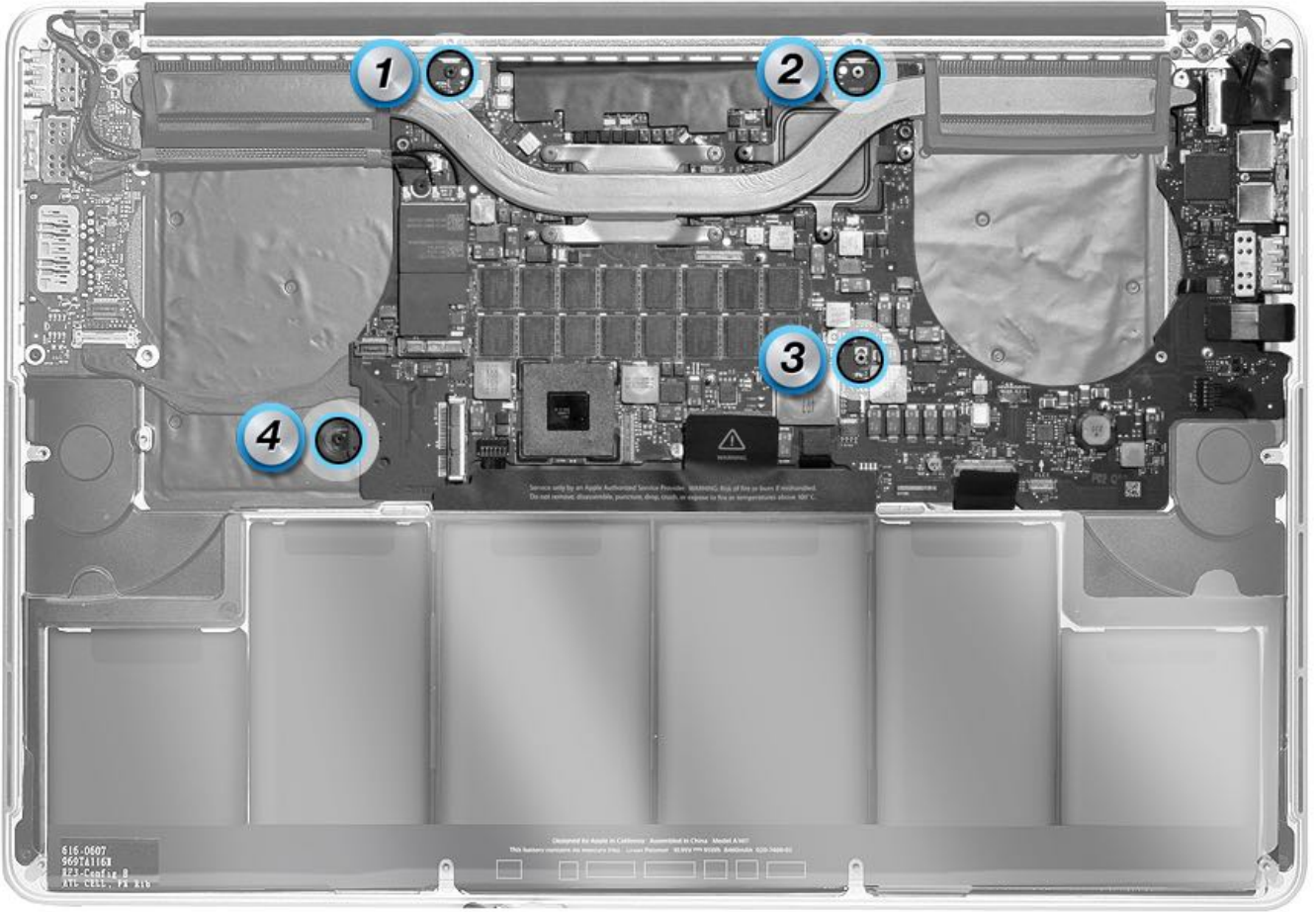


- #3 screw  
One 923-0144 (2.95 mm)



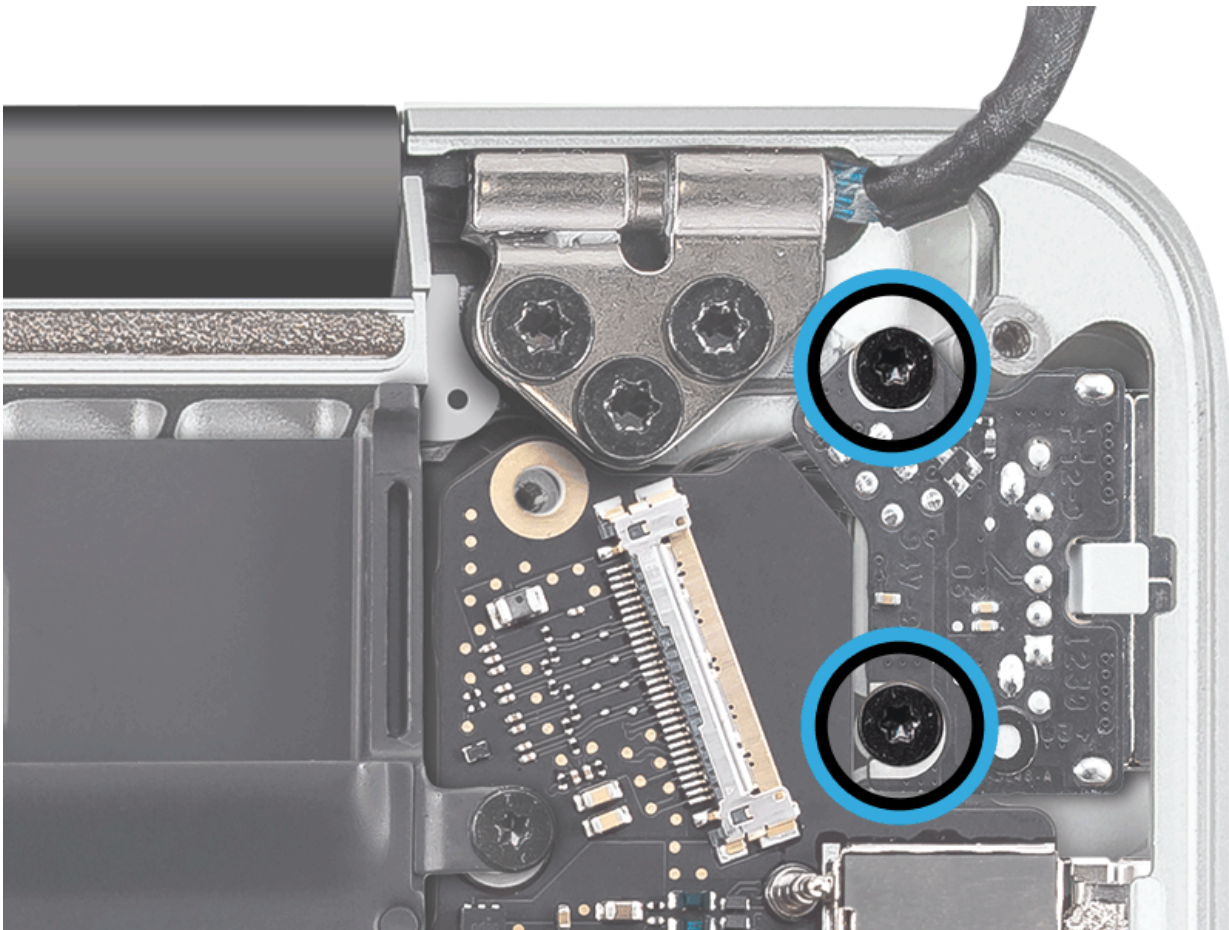
- #4 screw  
One 923-0140 (2.0 mm)





8. Remove the two T5 screws that secure the MagSafe 2 board.





**Note:** In steps 9–12, follow safe handling:

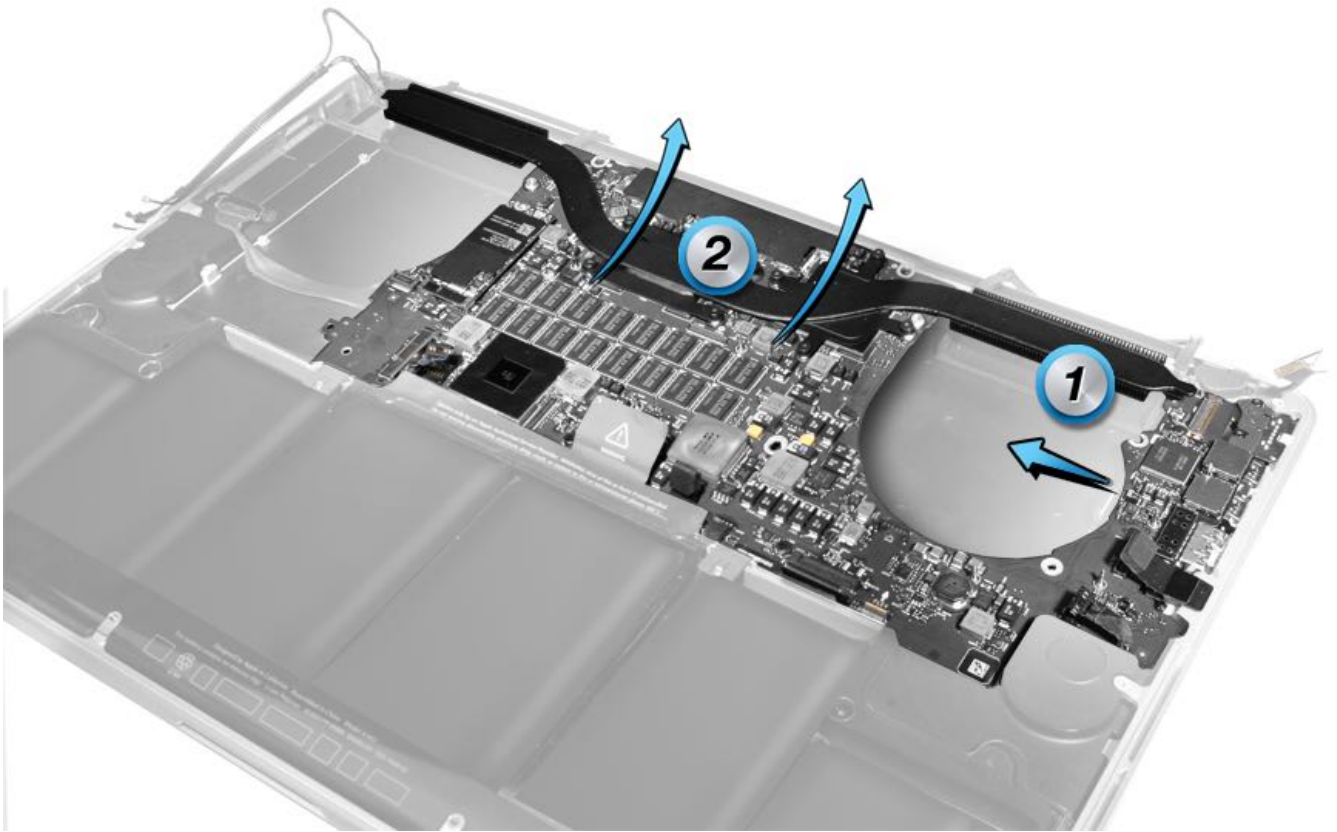
- Hold the board by the edges
- Do not touch the heat sink or connectors
- Do not touch circuitry

9. Slide the logic board a short distance to the left so the ports clear the openings in the case.

**Note:** In the next step, be aware that the logic board is attached to the top case by the MagSafe 2 cable. For video instruction, refer to articles:

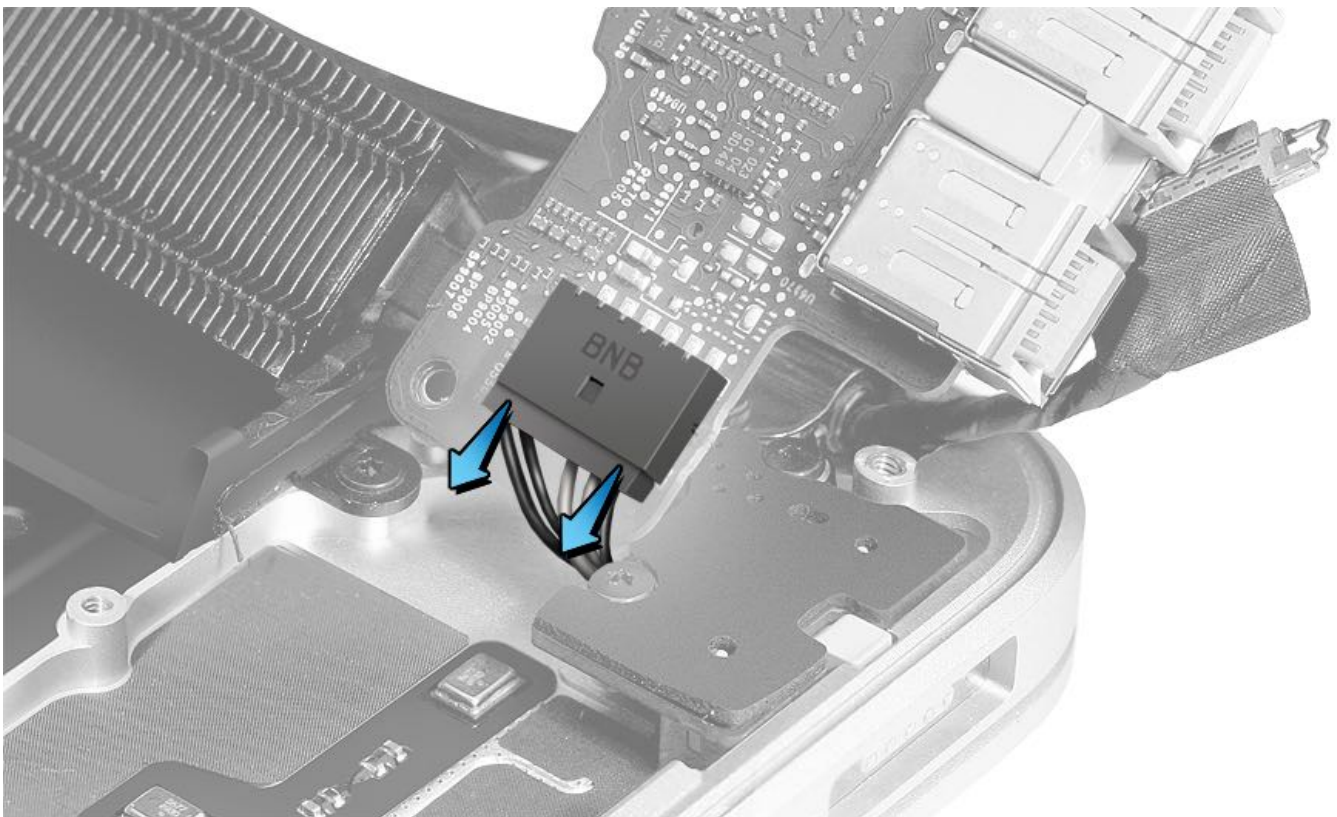
10. Tilt the top edge of the board up to a 30-degree angle and maneuver the board out of the case a short distance.

**Caution:** The angle of the tilt is important to prevent connector damage.



11. For MacBook Pro (Retina, 15-inch, Mid 2012 and Early 2013), remove the logic board from the top case with the MagSafe 2 board attached.

For MacBook Pro (Retina, 15-inch, Late 2013, Mid 2014, and Mid 2015), remove the logic board from the top case with the MagSafe 2 board attached. Turn the logic board over and disconnect the MagSafe 2 board from the logic board.



## Steps For Reassembly

**Reassembly Note:** If you are installing a replacement logic board, remove and transfer these parts to the replacement board:

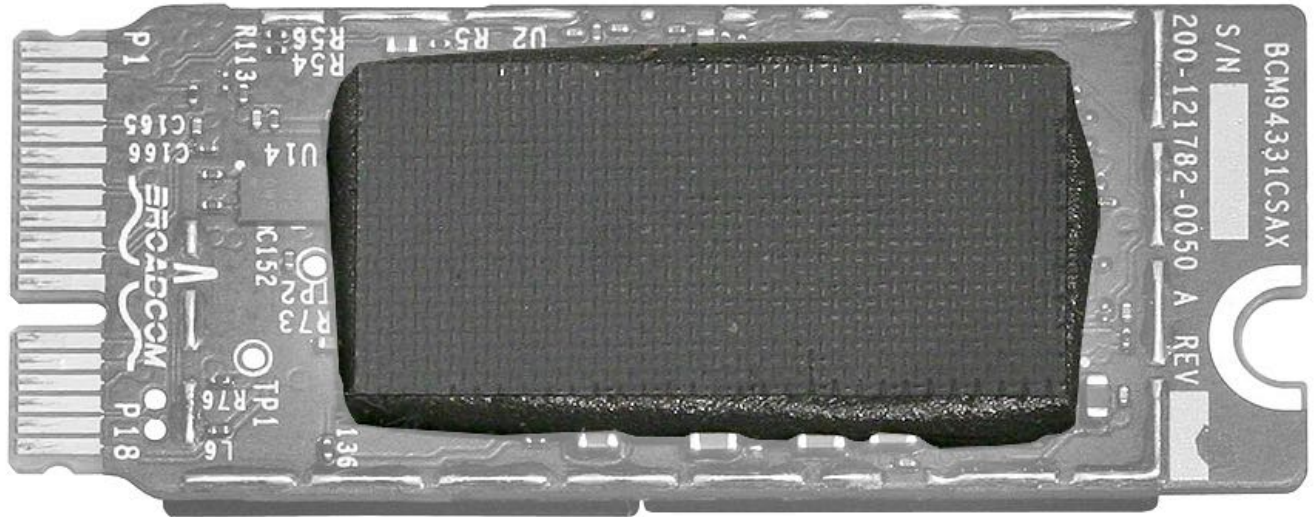
- [Wireless card](#)
- [Heat sink](#) (Mid 2012 and Early 2013)



- [Heat sink](#) (Late 2013 and Mid 2014)
- [Heat sink](#) (Mid 2015)
- [I/O coax cable](#)

Transfer the I/O coax cable to the replacement board before installing it in the top case. Transfer the wireless card and heat sink to the replacement board after installing the replacement board in the case.

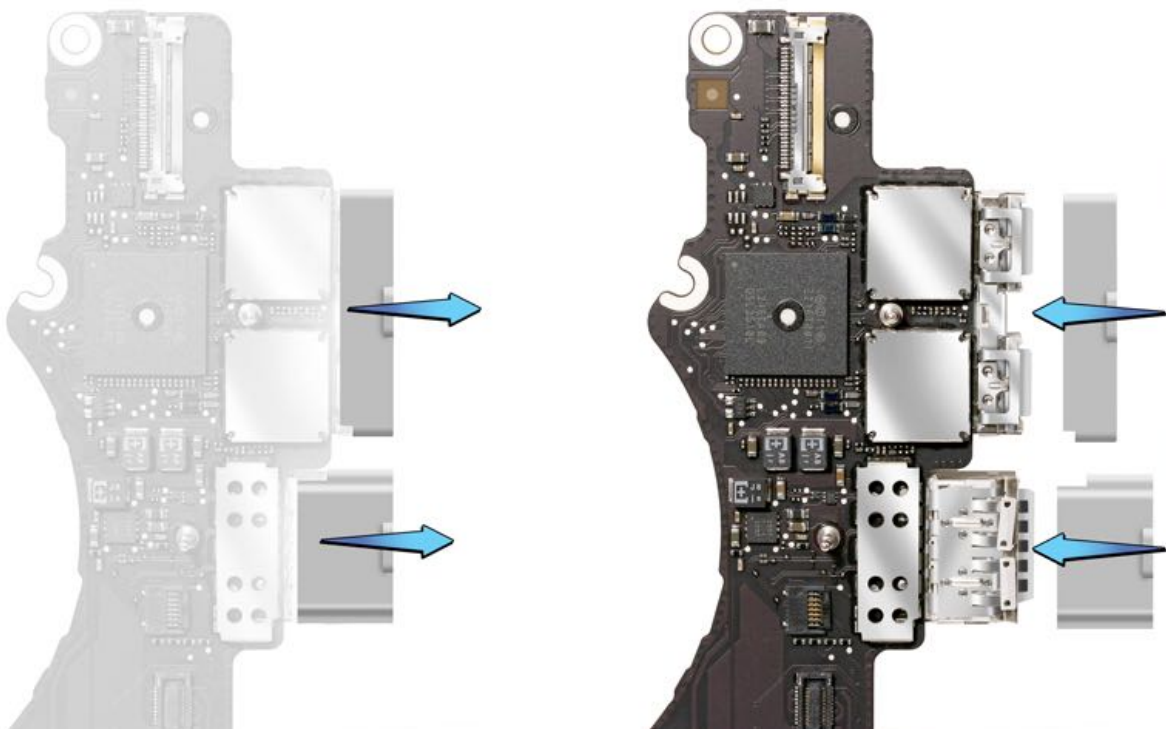
**Note:** If the wireless card gasket adheres to the original board, carefully peel up the gasket and reattach it to the underside of card as shown. If the gasket is damaged, apply a new gasket (923-0150).



Reassemble in reverse order of removal steps.

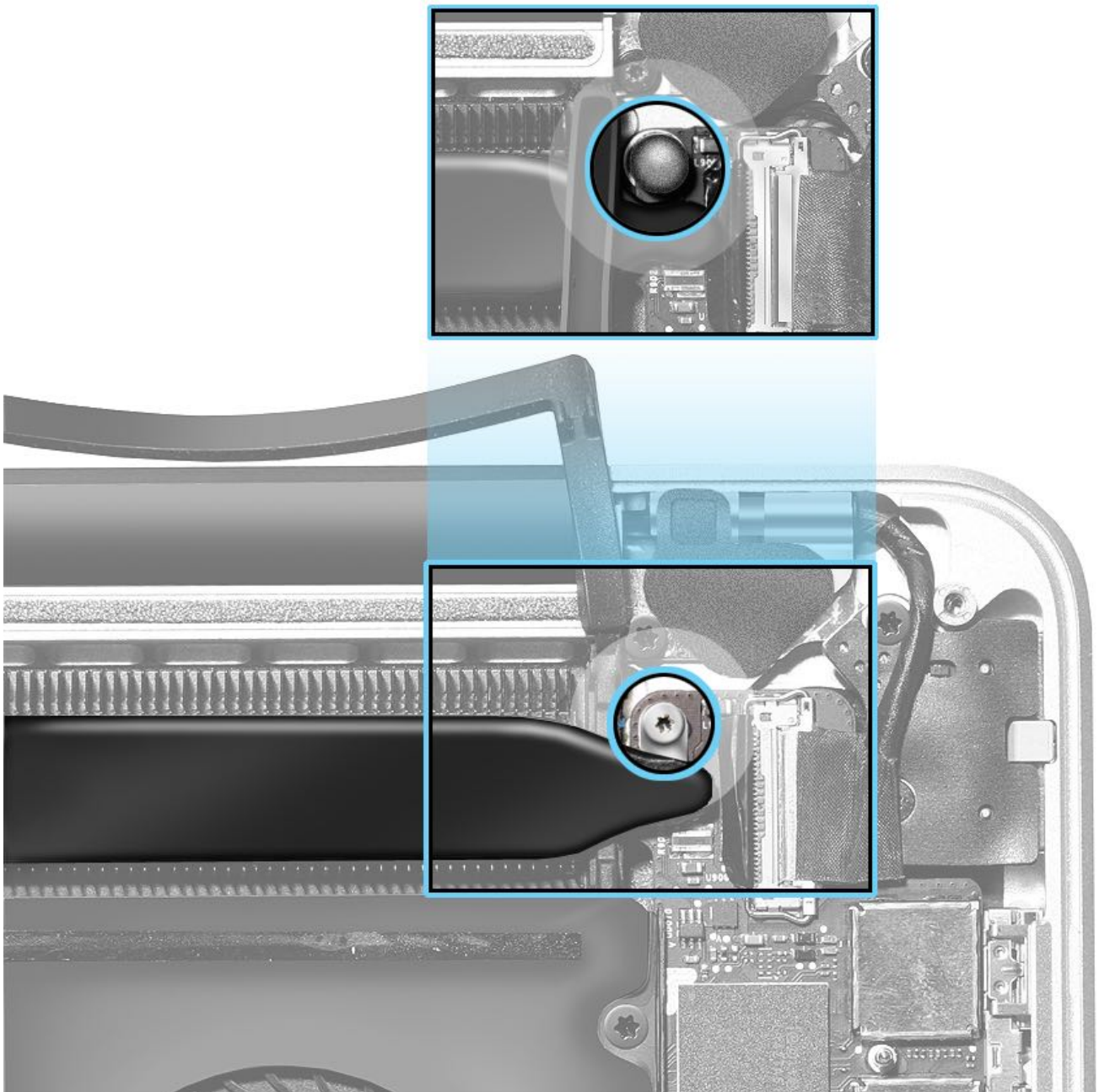
**Important:** Just prior to installing a replacement logic board, remove the port covers. Before returning the original board, attach the covers to minimize board damage during shipping and handling. A returned logic board without port covers is easily damaged and may not be accepted for return.

**Note:** Extra board covers can be ordered as part number 076-1427.



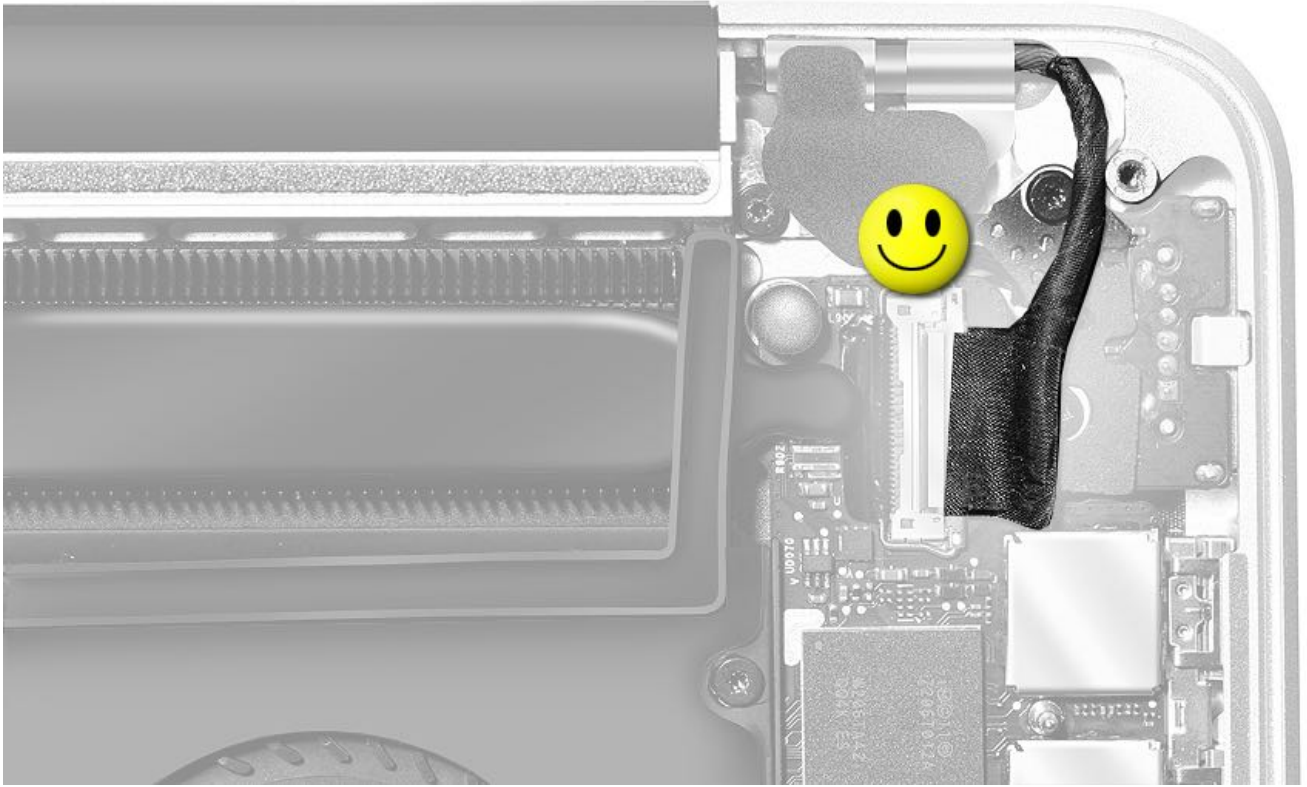
**Reassembly Notes:**

- Install the board at a 30-degree angle, using caution at the ports to prevent damage to the metal EMI ground tabs. Make sure the ground tabs fit under the lip of the top case.
- As you connect the cables, remove any pieces of Kapton tape that were used to set the cables aside. Count the pieces of tape to be sure that none remain in the computer.
- Confirm that the ground cap is reinstalled before closing the computer.

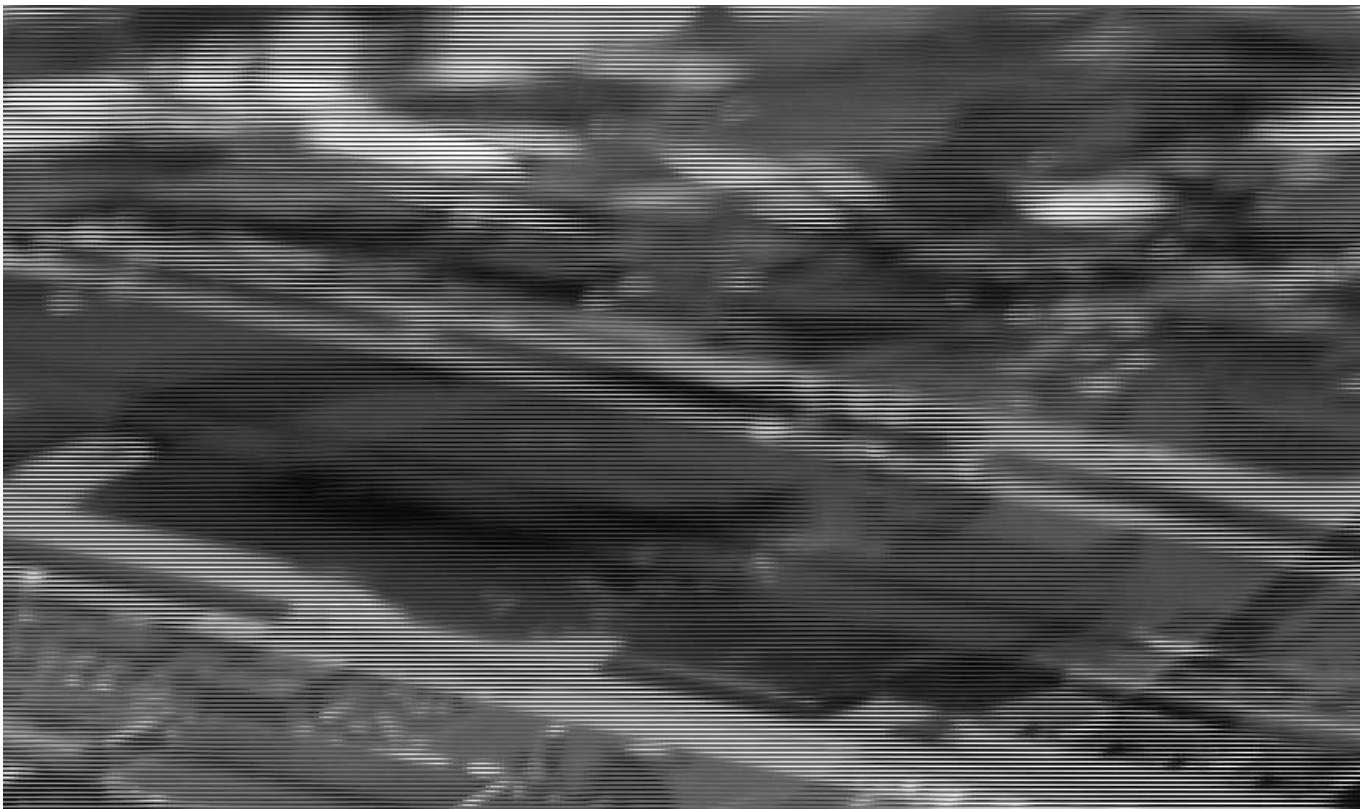


**Reassembly Note:** If improperly routed, the eDP cable can be pinched when the bottom case is installed. To prevent damage, check that the cable is routed between the screw and the standoff.





**Reassembly Note:** Before screwing down the logic board, check port alignment by inserting a connector from a USB or Thunderbolt device into the port.



**For MacBook Pro (Retina, 15-inch, Mid 2015) only:** Trackpad performance must be validated after every repair.

- **Important:** When using BBS in AST 1 or AST 2, ensure that the unit under test (UUT) and the AST server are connected to the same network, and that the AST server has the latest software version installed.



# Heat Sink

## First Steps

**Important:** This procedure should only be performed by Apple-certified technicians.

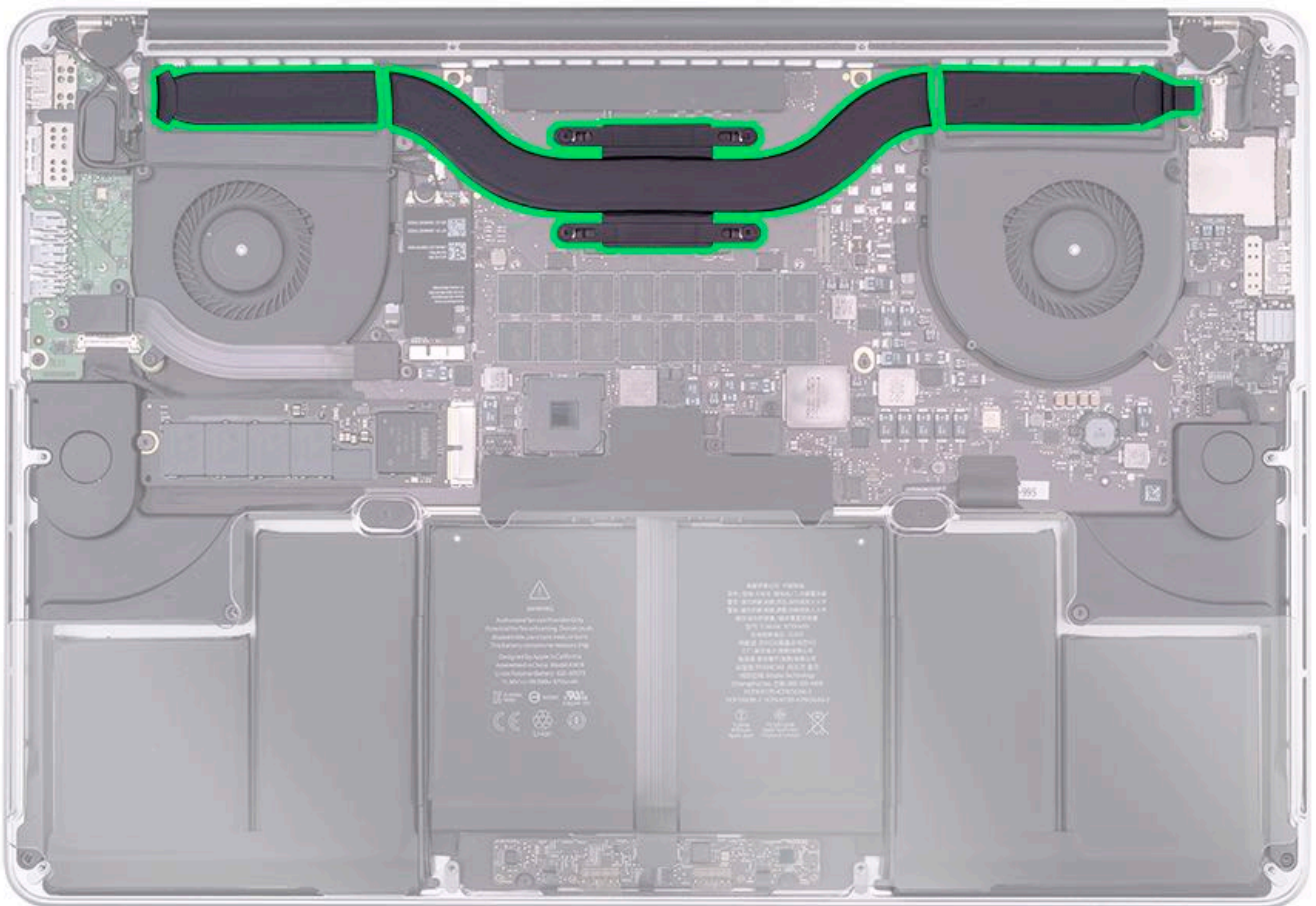
Remove:

- [Bottom case](#)

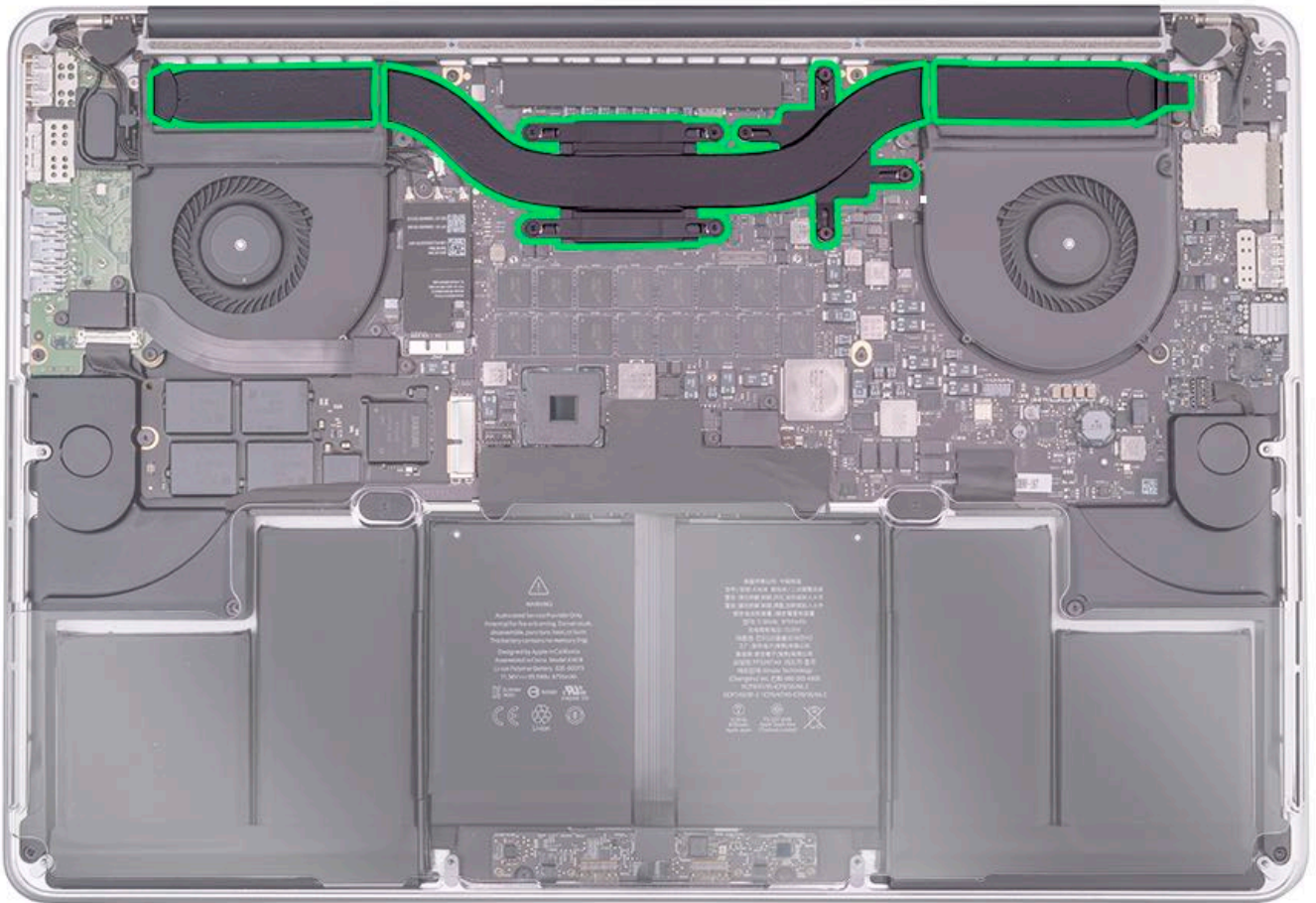


**Warning:** Always [attach the battery cover and disconnect the battery cable](#) immediately after removing the bottom case.

## Integrated GPU



## Discrete GPU



## Tools

- ESD wrist strap
- Torx T5 screwdriver (magnetized)
- Isopropyl alcohol (IPA) wipes
- Thermal grease syringe (922-7144)
- Black stick



## Steps For Removal

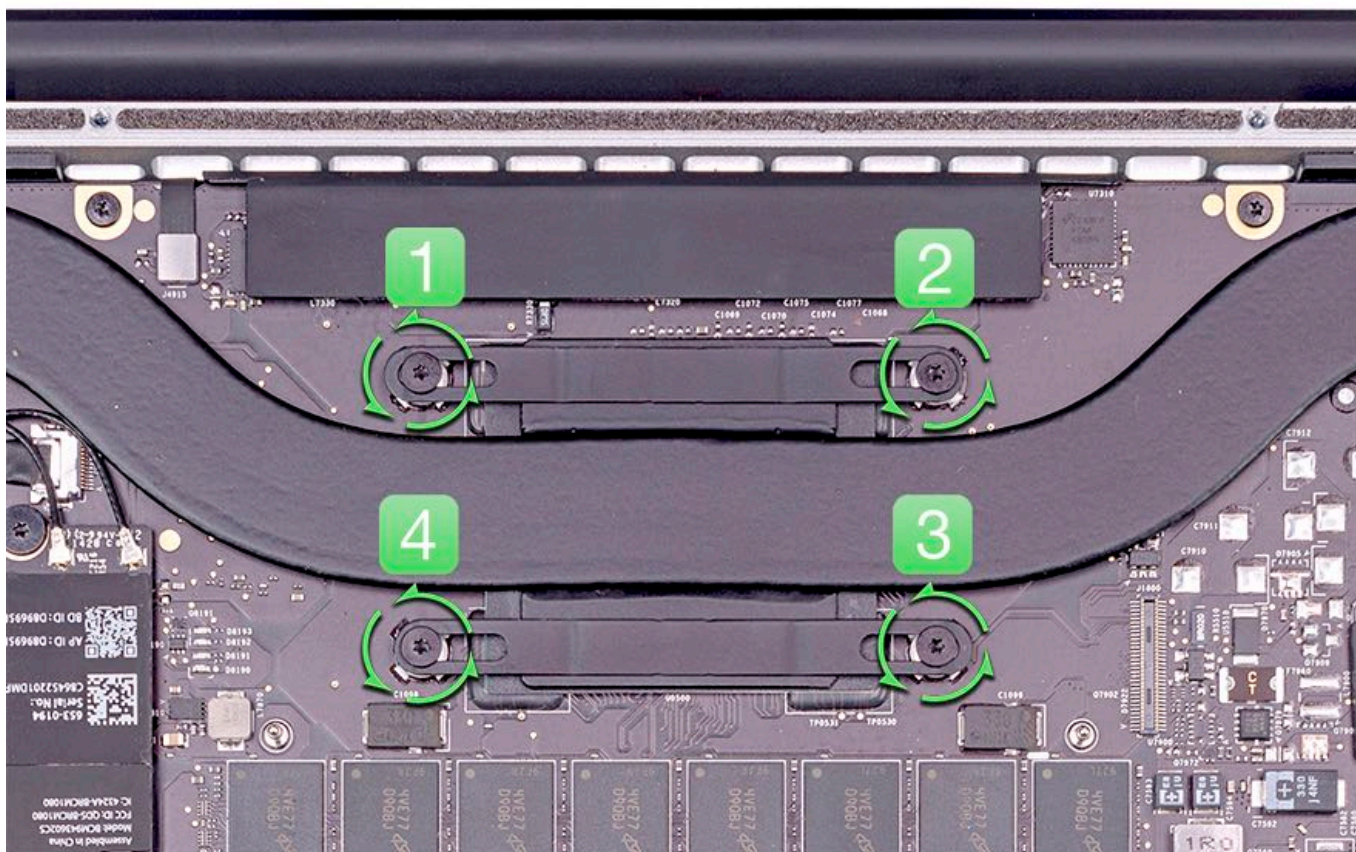
**For Integrated GPU configuration:**

1. Remove Torx T5 heat sink screws in the order indicated.

- Four T5: 923-00546







#### For Discrete GPU configuration:

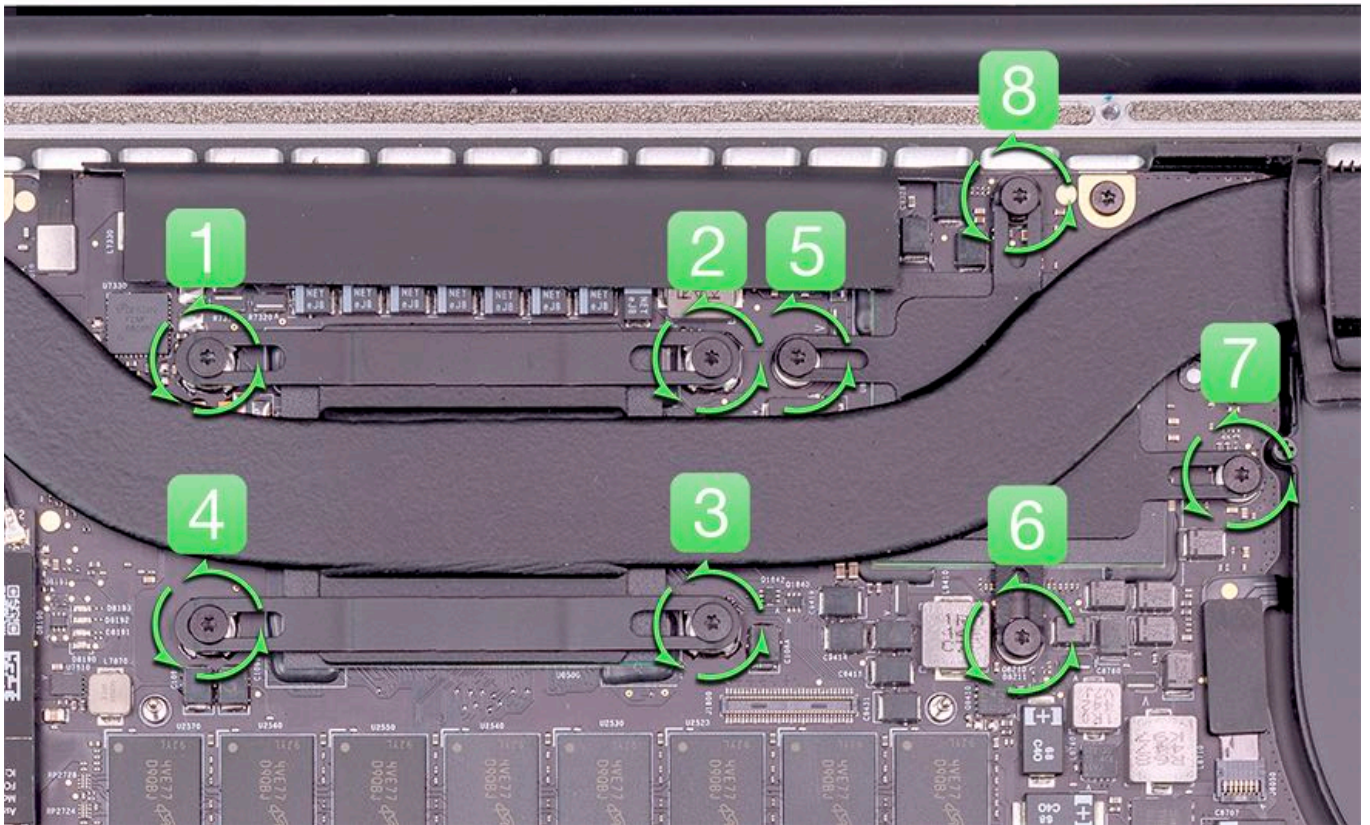
1. Remove Torx T5 heat sink screws in the order indicated.

- Four T5: 923-00546 (positions 1–4)



- Four T5: 923-00554 (positions 5–8)





**Note:** For both configurations, there are two separate flexures that secure the heat sink with screws at positions 1, 2, 3, and 4:

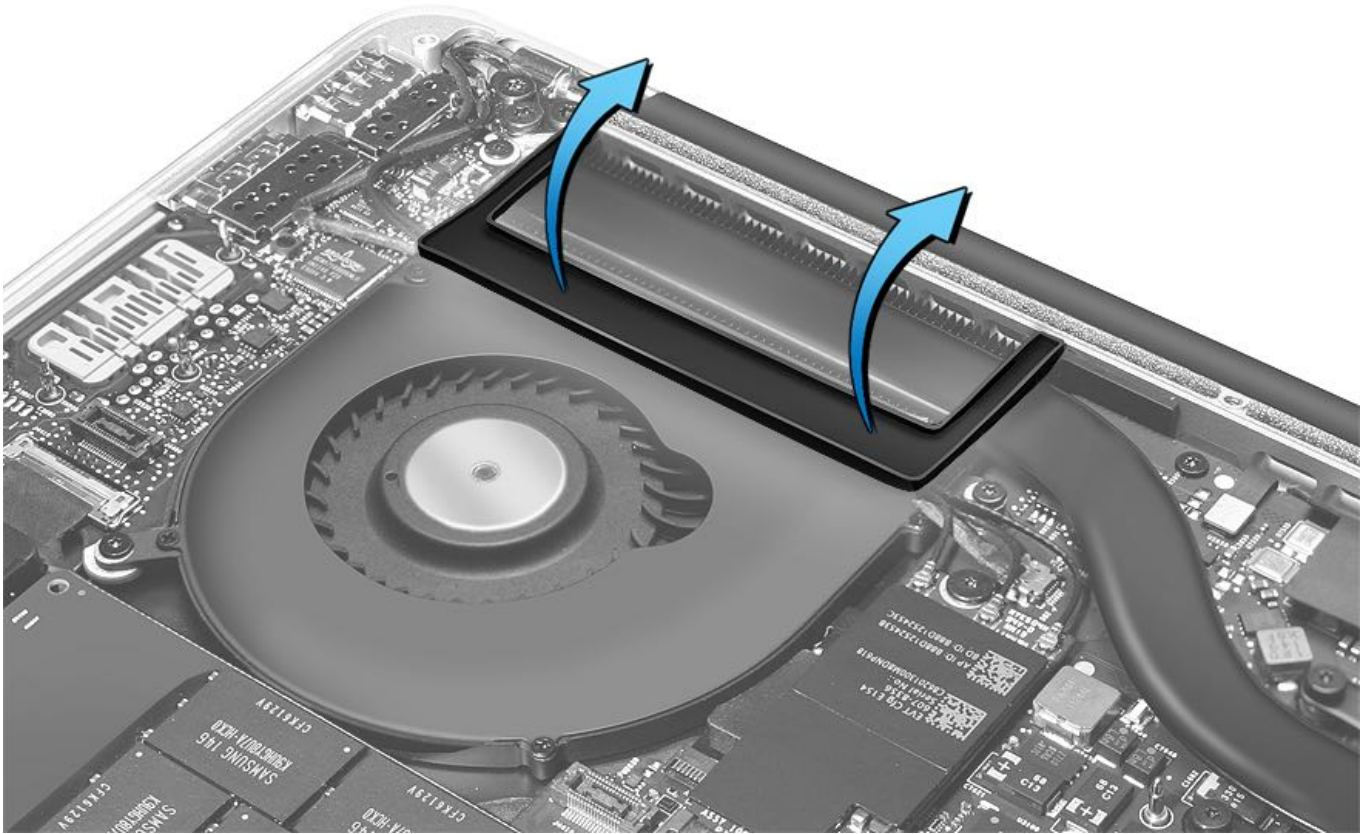


**Note:** In the following two steps, the fan duct gaskets are attached to the fans with adhesive. Use care when separating them from the fans.

**Important:** If a gasket is damaged or torn, the fan duct must be replaced, which requires removing the logic board.

2. Separate right fan duct gasket from the fan and rotate the gasket out of the way.
3. Repeat for the left fan duct gasket.

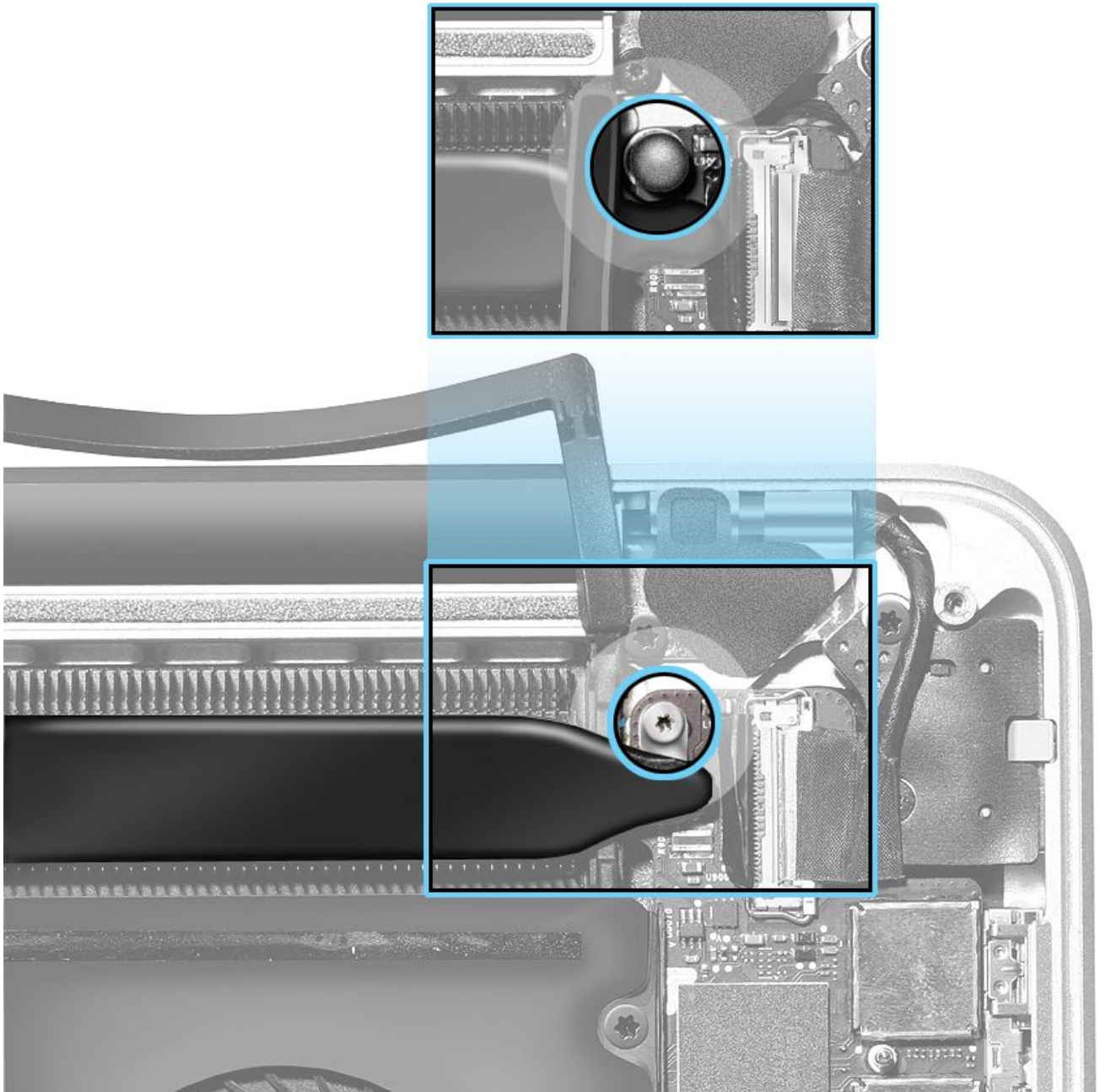




4. Remove the ground cap and one left-end heat sink Torx T5 screw.

- One 923-0681



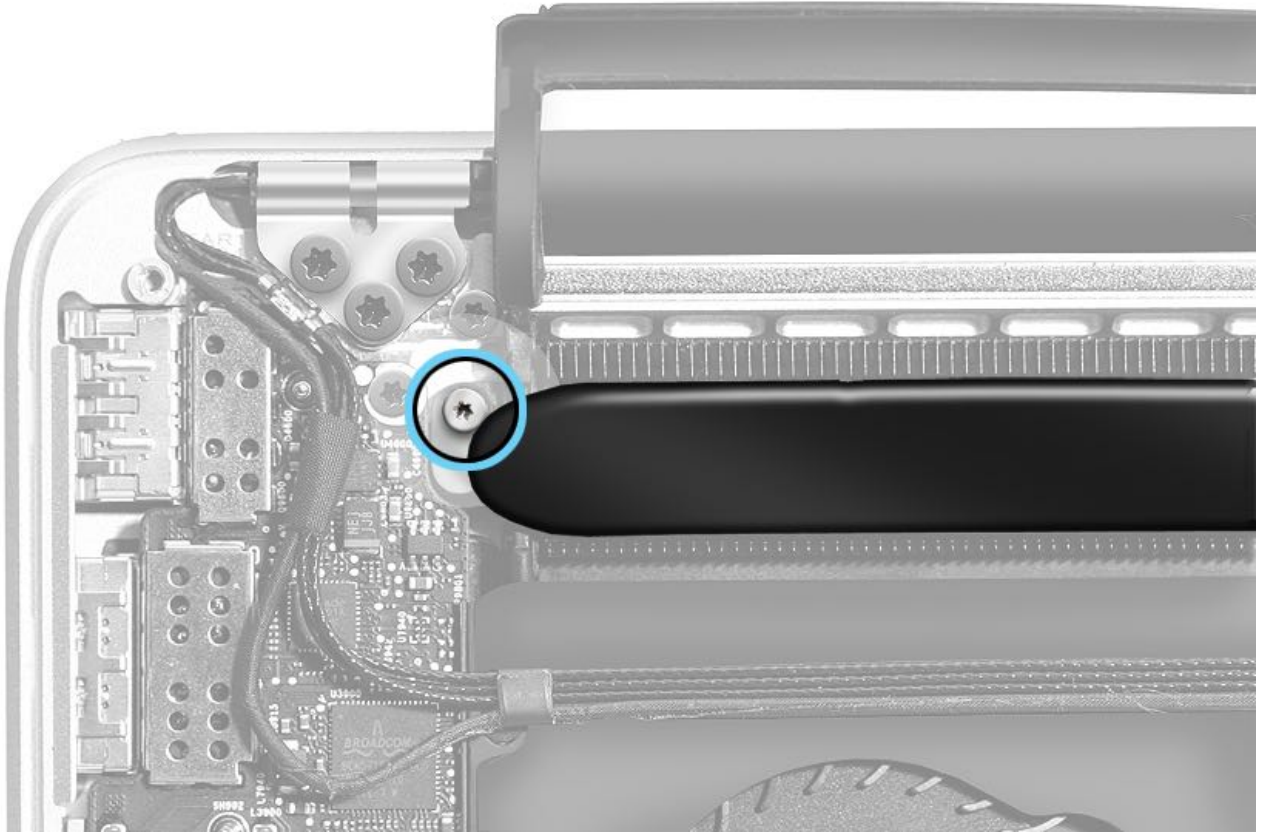


5. Remove one right-end heat sink Torx T5 screw:

- One 923-00538







**Caution:** Do not grasp the heat sink by the arms.

6. Keeping the heat sink parallel to the logic board, gently wiggle the heat sink to loosen the bond on the logic board and lift the heat sink off the logic board.

7. Scrape off any thermal grease and use an IPA wipe to clean the thermal pads and chips.

### Integrated GPU configuration



### Discrete GPU configuration

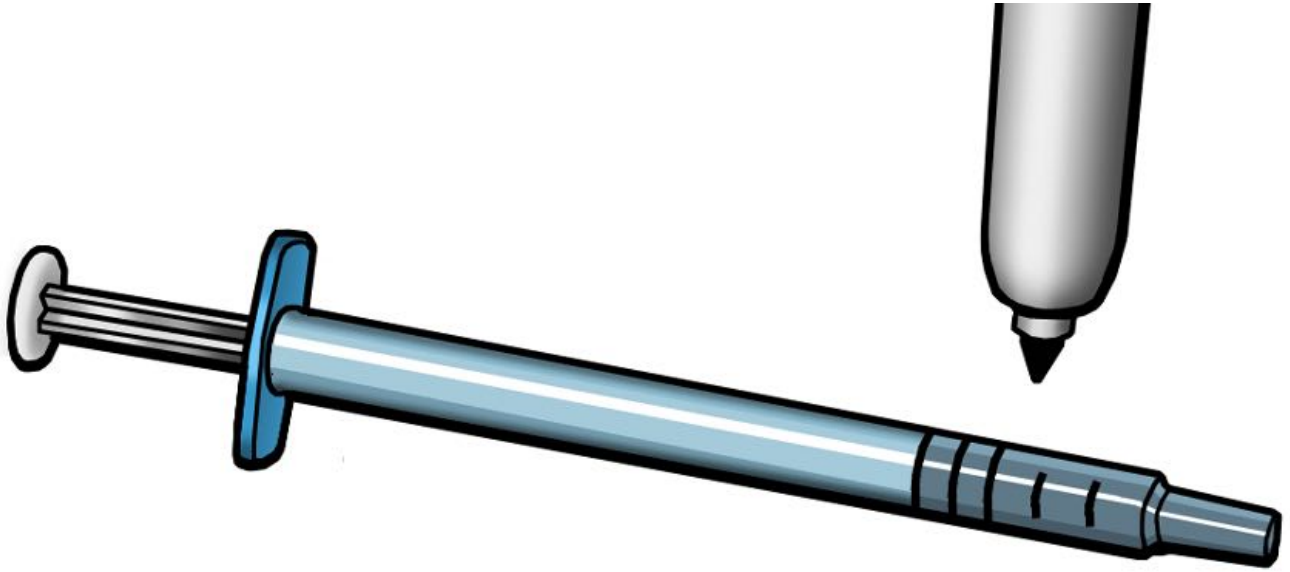


### Steps For Reassembly

1. Use a pen to mark the syringe according to the instructions in reassembly step 2 for the model being serviced.

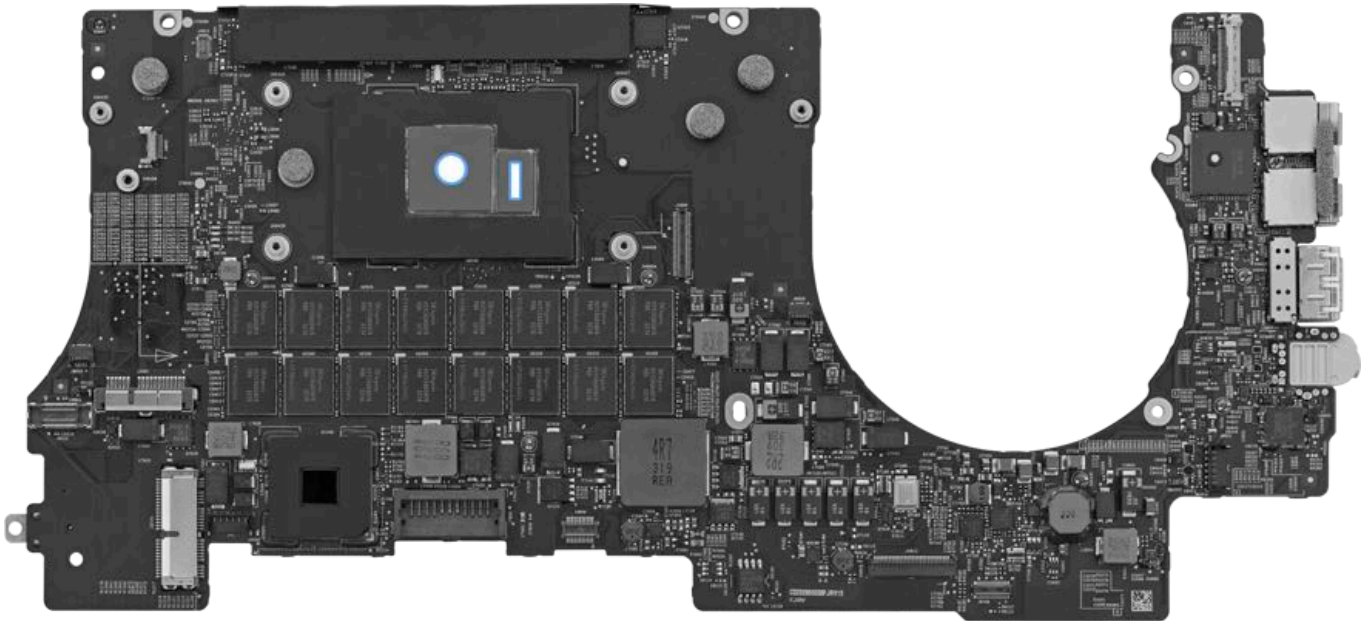


**Caution:** The syringe (922-7144) contains enough thermal grease for three chips. Apply no more than the amount specified in reassembly step 2 for the model being serviced.

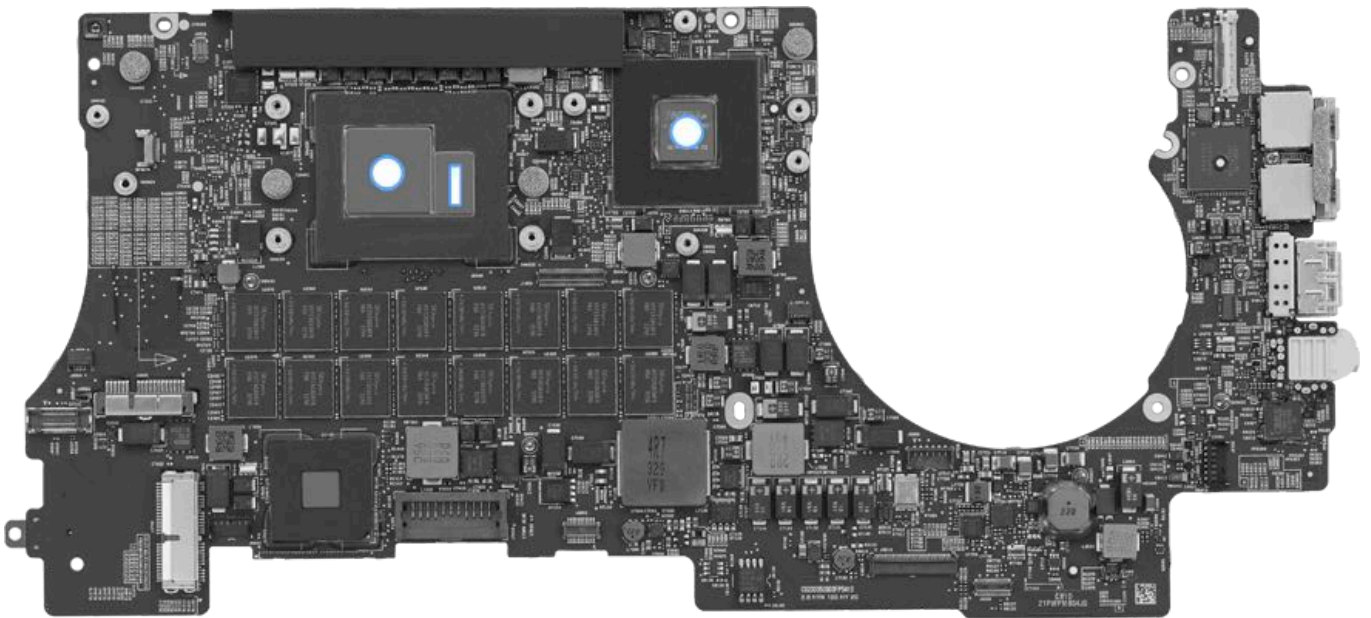


2. Apply thermal grease to the chips, using the correct instruction below for the model being serviced.

For the **Integrated GPU configuration**, inject one-third of the grease onto the center of the larger chip and one-fourth of the grease along the center line of the smaller chip, as shown.



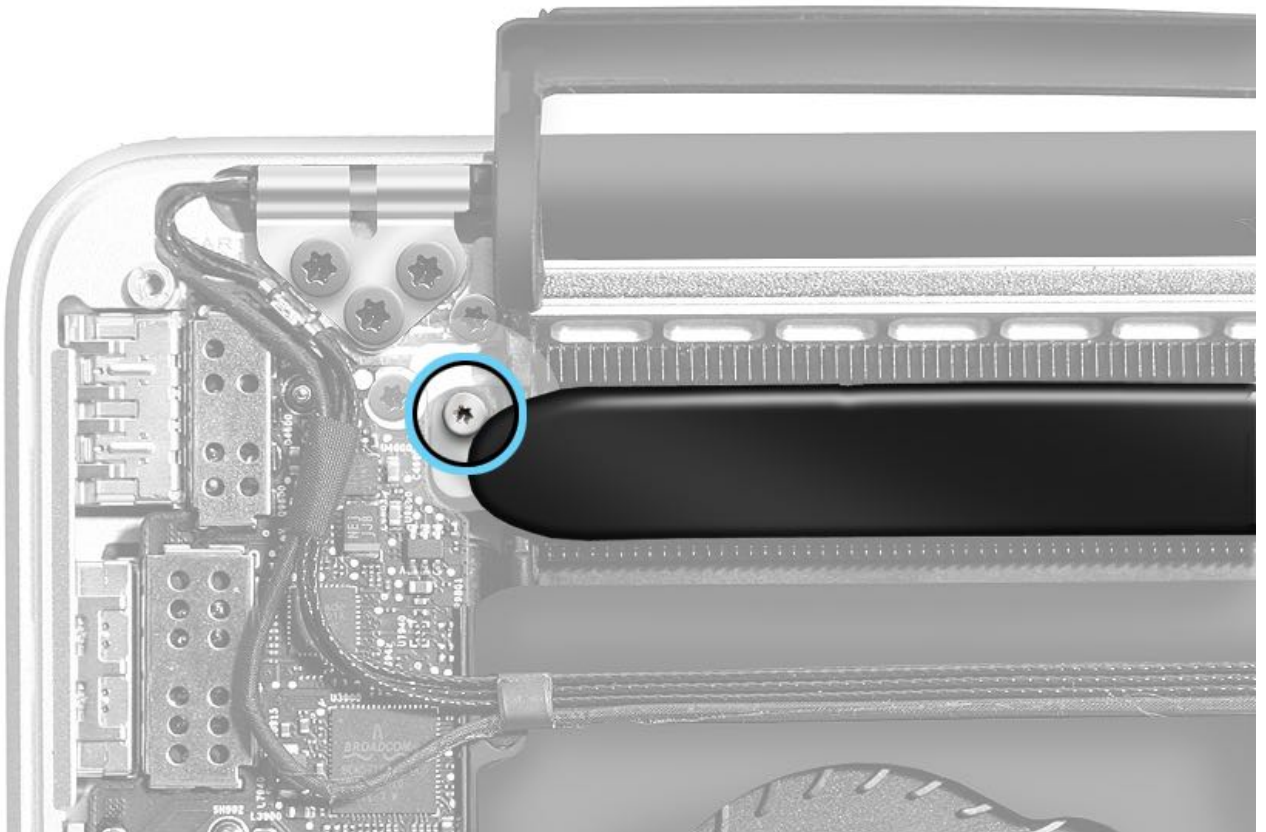
For **Discrete GPU configuration**, inject one-third of the grease onto the center of the larger CPU chip, one-fourth of the grease along the center line of the smaller CPU chip, and one-third of the grease onto the center of the GPU chip, as shown.



3. Install the heat sink on the logic board.

4. Replace one right-end heat sink Torx T5 screw.

- One 923-00538



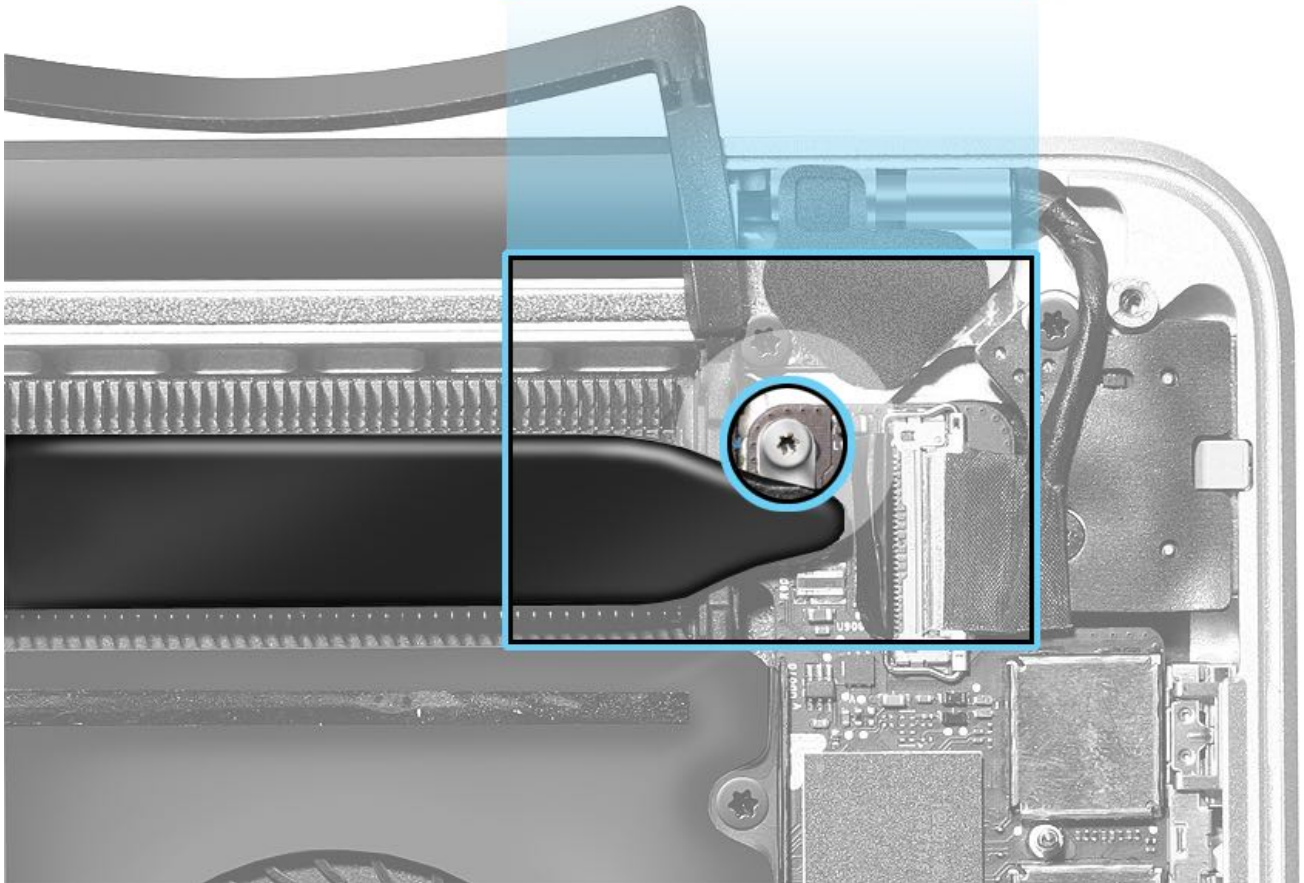
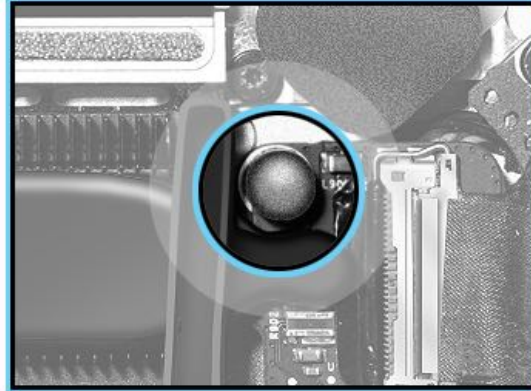
5. Replace one left-end heat sink screw and ground cap.

- One 923-0681





**Note:** The ground cap is available as part 923-0111.



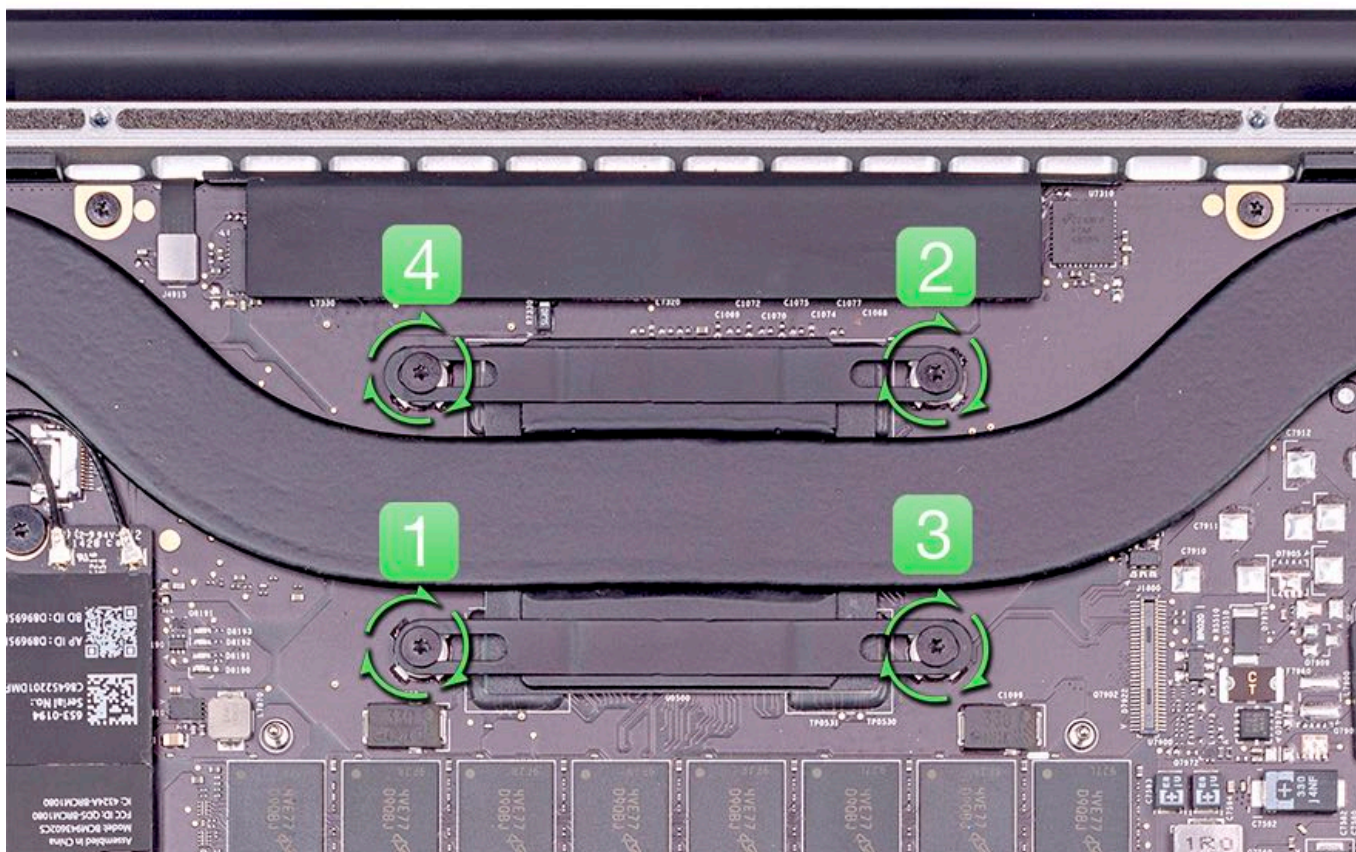
6. Replace Torx T5 screws in the order shown. Install the screws halfway first, then tighten them in the same order.

**For Integrated GPU configuration:**

- Four T5: 923-00546







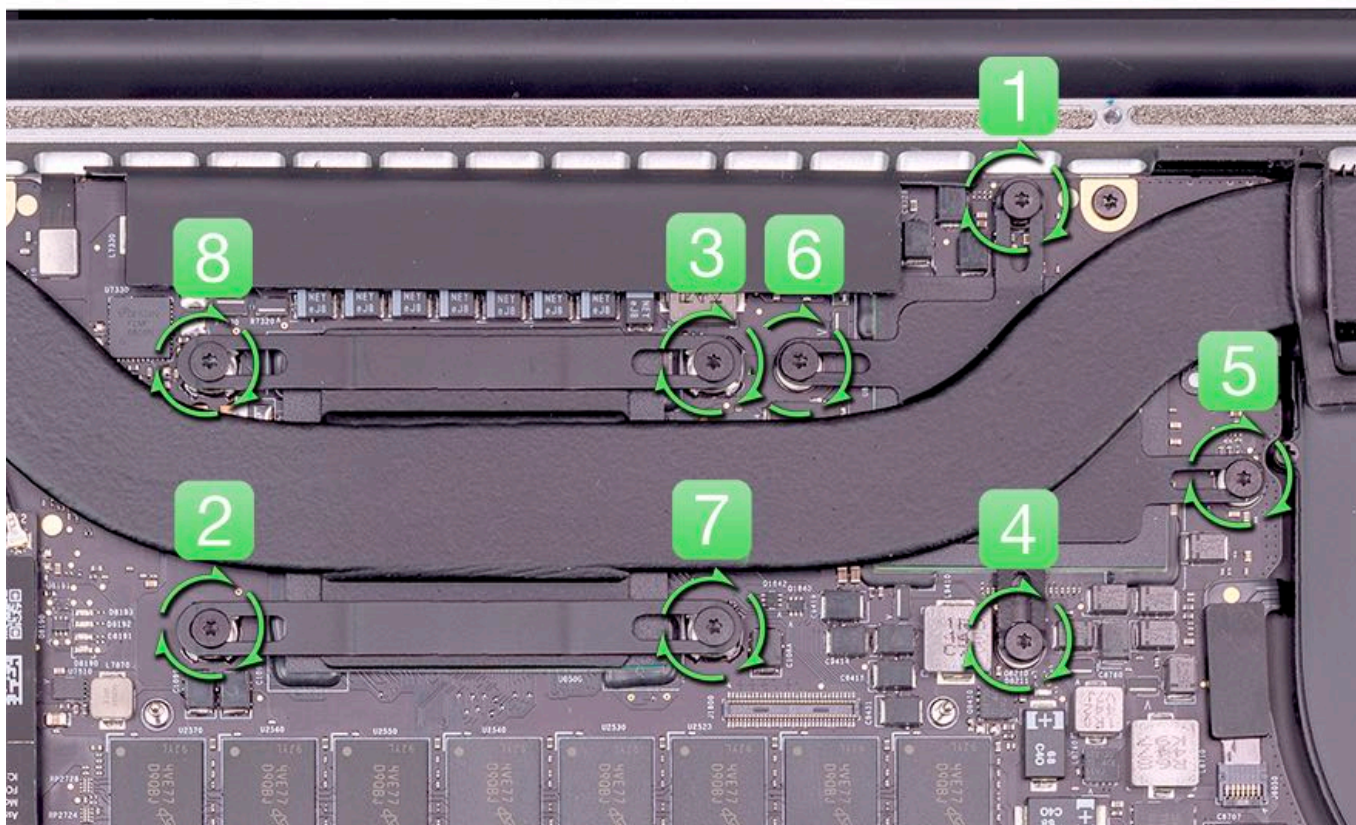
**For Discrete GPU configuration:**

- Four T5: 923-00546 (positions 2, 3, 7, 8)



- Four T5: 923-00554 (positions 1, 4, 5, 6)





For both models, be sure to reinstall the flexures.



7. Return the fan duct gaskets to their original position. Press down gently to adhere the gaskets to the fans.

8. Trackpad performance must be validated after every repair.

# Input/Output (I/O) Coax Cable

## First Steps

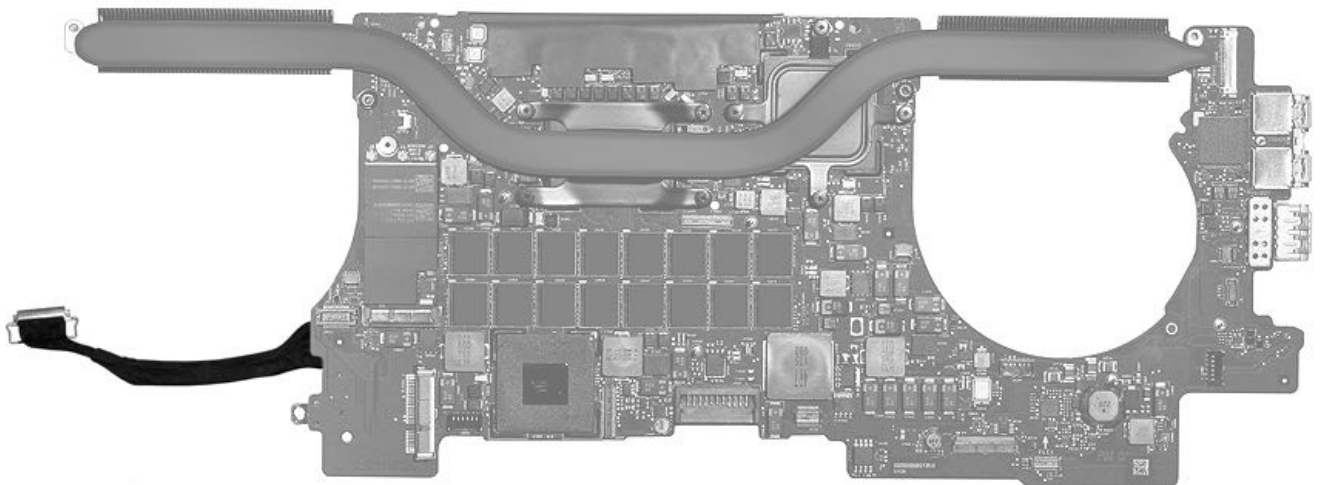
**Important:** This procedure should only be performed by Apple-certified technicians.

Remove:

- [Bottom case](#)
- [SSD card or flash storage](#)
- [I/O flex cable](#) (Mid 2012 and Early 2013)
- [I/O flex cable](#) (Late 2013 and Mid 2014)
- [I/O flex cable](#) (Mid 2015)
- [Right fan](#)
- [Left fan](#)
- [Logic board](#)



**Warning:** Always [attach the battery cover and disconnect the battery cable](#) immediately after removing the bottom case.



## Tools

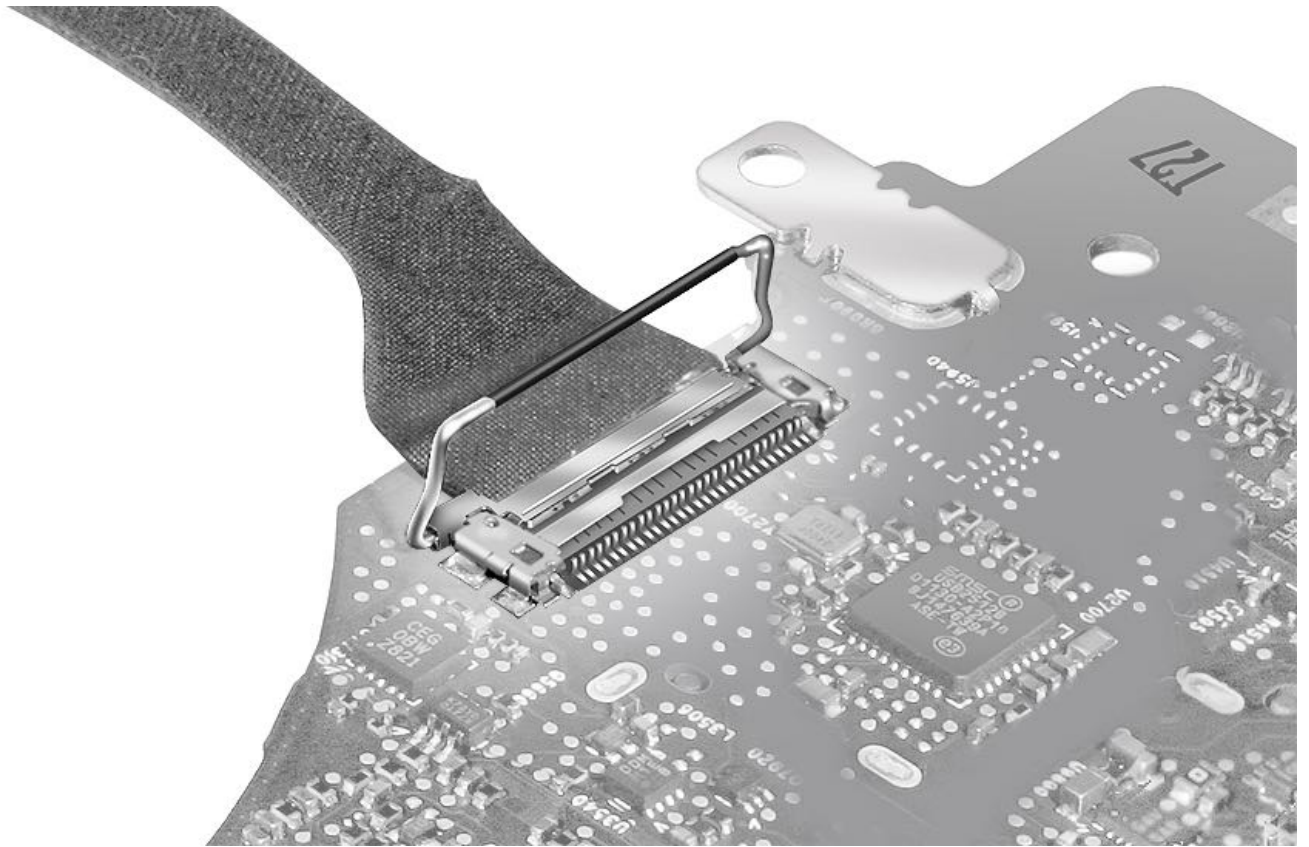
- ESD wrist strap
- Black stick



## Steps For Removal

1. On the underside of logic board, lift the locking bar on the I/O coax cable and rotate the cable back from the connector.
2. Disconnect the cable and remove it from the top case.





## Steps For Reassembly

Reassemble in reverse order of removal steps.

**For MacBook Pro (Retina, 15-inch, Mid 2015) only:** Trackpad performance must be validated after every repair.



# Right and Left Speakers

## First Steps

**Important:** This procedure should only be performed by Apple-certified technicians.

Remove:

- [Bottom case](#)
- [SSD card or flash storage](#)
- [I/O flex cable](#) (Mid 2012 and Early 2013)
- [I/O flex cable](#) (Late 2013 and Mid 2014)
- [I/O flex cable](#) (Mid 2015)
- [Right fan](#)
- [Left fan](#)
- [I/O board](#)
- [Logic board](#)

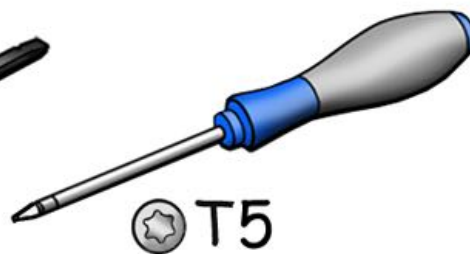


**Warning:** Always [attach the battery cover and disconnect the battery cable](#) immediately after removing the bottom case.



## Tools

- ESD wrist strap
- Black stick
- Torx T5 screwdriver (magnetized)



T5

## Steps For Removal

1. For both right and left speakers, remove three Torx T5 screws:

- One 923-0143 (short, top)



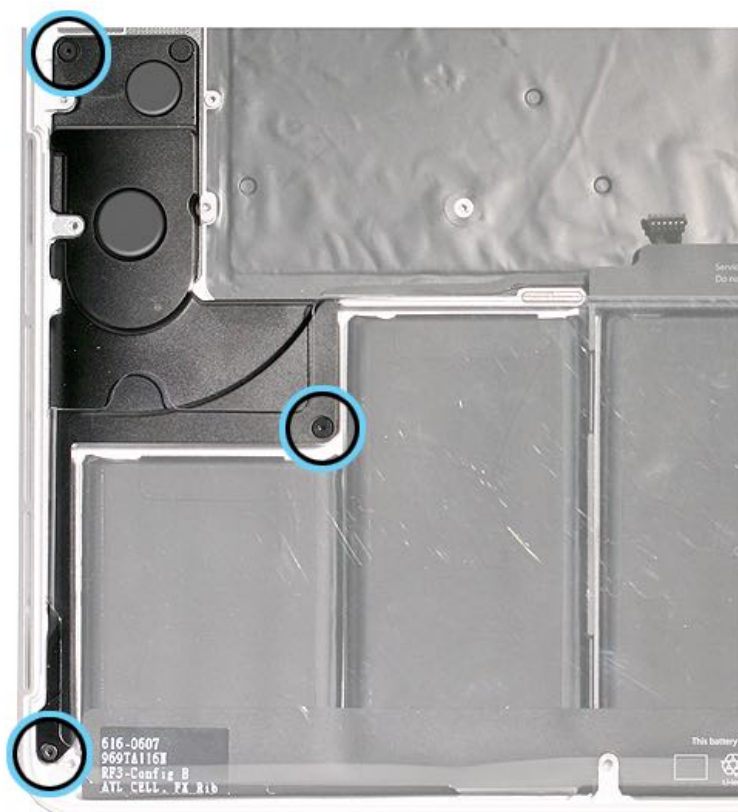
- One 923-0146 (long shoulder, middle)



- One 923-0138 (medium, bottom)

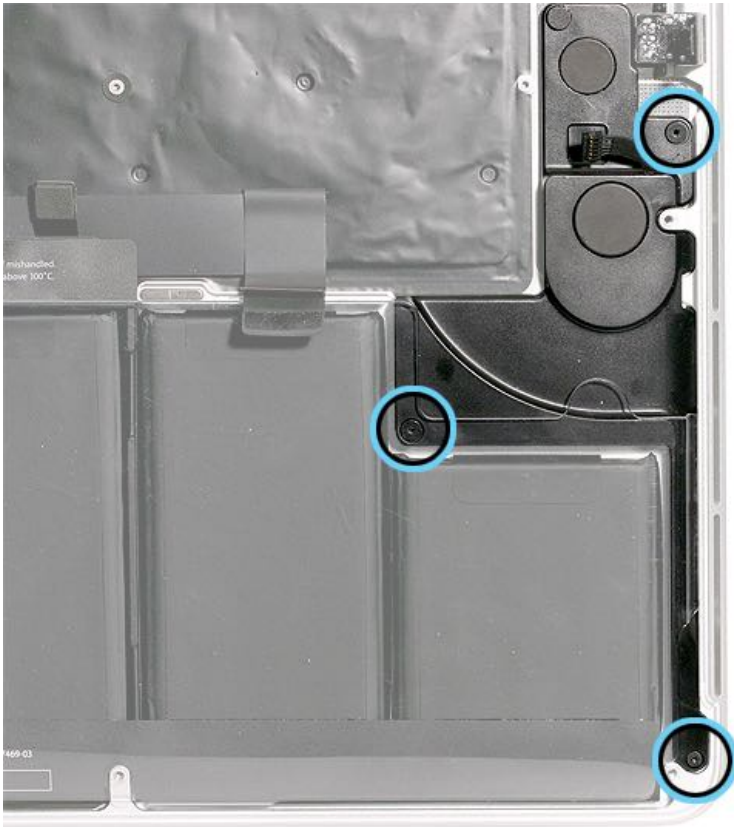


**Note:** The right speaker cable is attached to the top case with adhesive. Use a black stick to carefully free the cable from the case before removing the speaker.



2. Tilt up the battery cover and remove the speaker.

**Important:** For optimum performance, the left and right speakers are paired. If you are replacing one speaker, you must replace both speakers. Speaker kit 076-1401 includes both left and right speakers. Do not save any used speakers, even if functional, for use in another computer.



### Steps For Reassembly

For both right and left speakers, reassemble in reverse order of removal steps.

**For MacBook Pro (Retina, 15-inch, Mid 2015) only:** Trackpad performance must be validated after every repair.

# MagSafe 2 Board

## First Steps

**Important:** This procedure should only be performed by Apple-certified technicians.

Remove:

- [Bottom case](#)
- [SSD card or flash storage](#)
- [I/O flex cable](#) (Mid 2012 and Early 2013)
- [I/O flex cable](#) (Late 2013 and Mid 2014)
- [I/O flex cable](#) (Mid 2015)
- [Right fan](#)
- [Left fan](#)
- [I/O board](#)
- [Logic board](#)



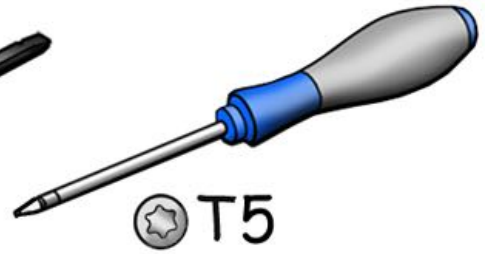
**Warning:** Always [attach the battery cover and disconnect the battery cable](#) immediately after removing the bottom case.



## Tools

- ESD wrist strap
- Black stick
- Torx T5 screwdriver (magnetized)





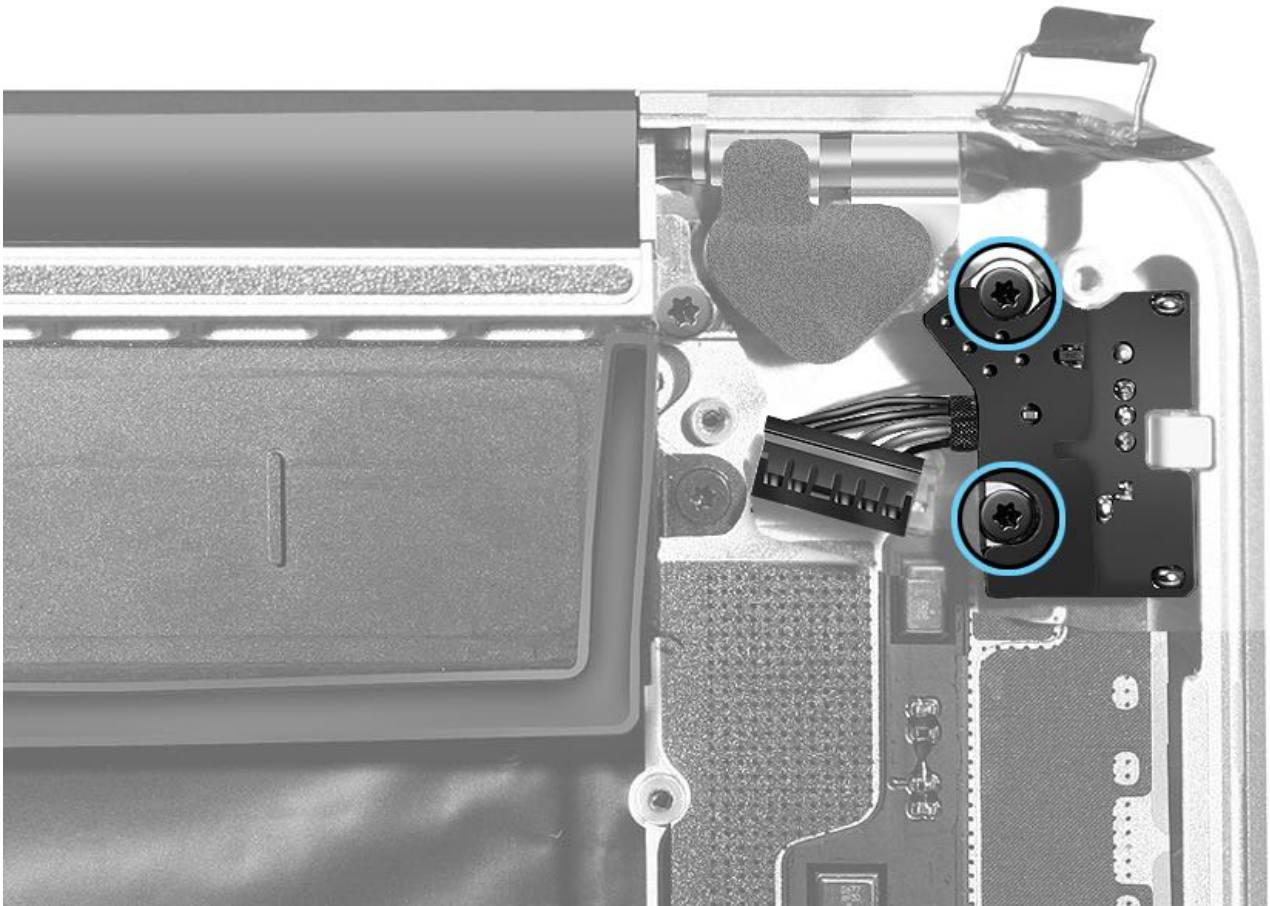
## Steps For Removal

1. Remove two Torx T5 screws:

- Two 923-0144 (2.95 mm)



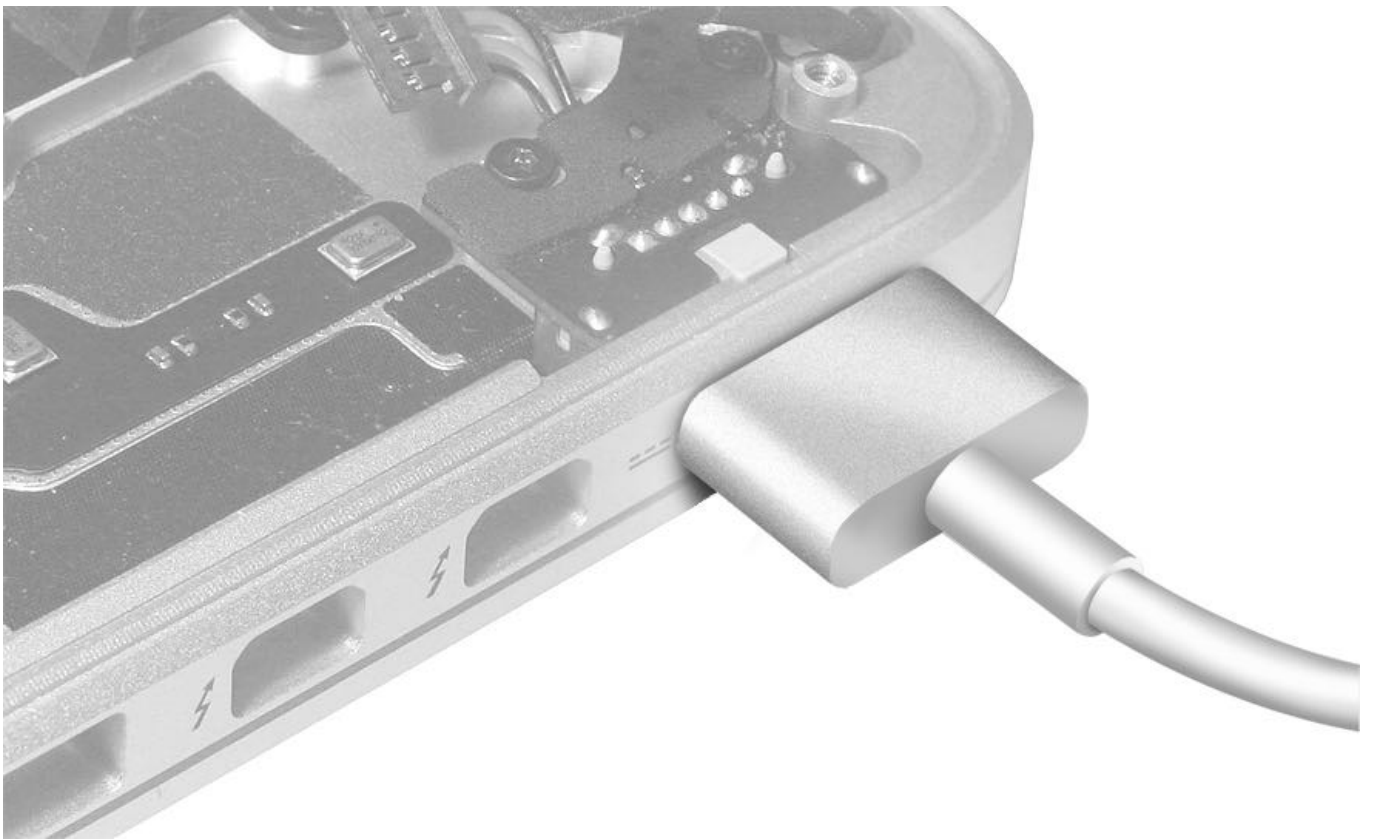
2. Remove the MagSafe 2 board from the case.



## Steps For Reassembly

Reassemble in reverse order of removal steps.

**Reassembly Note:** After installing the MagSafe 2 board screws, check the port connection by plugging in a disconnected power adapter cable. If the MagSafe 2 port is off center, the cable will not plug in securely, and you must reinstall the MagSafe 2 board.



**For MacBook Pro (Retina, 15-inch, Mid 2015) only:** Trackpad performance must be validated after every repair.

# Right Fan Duct

## First Steps

**Important:** This procedure should only be performed by Apple-certified technicians.

Remove:

- [Bottom case](#)
- [SSD card or flash storage](#)
- [I/O flex cable](#) (Mid 2012 and Early 2013)
- [I/O flex cable](#) (Late 2013 and Mid 2014)
- [I/O flex cable](#) (Mid 2015)
- [Right fan](#)
- [Left fan](#)
- [I/O board](#)
- [Logic board](#)



**Warning:** Always [attach the battery cover and disconnect the battery cable](#) immediately after removing the bottom case.



## Tools

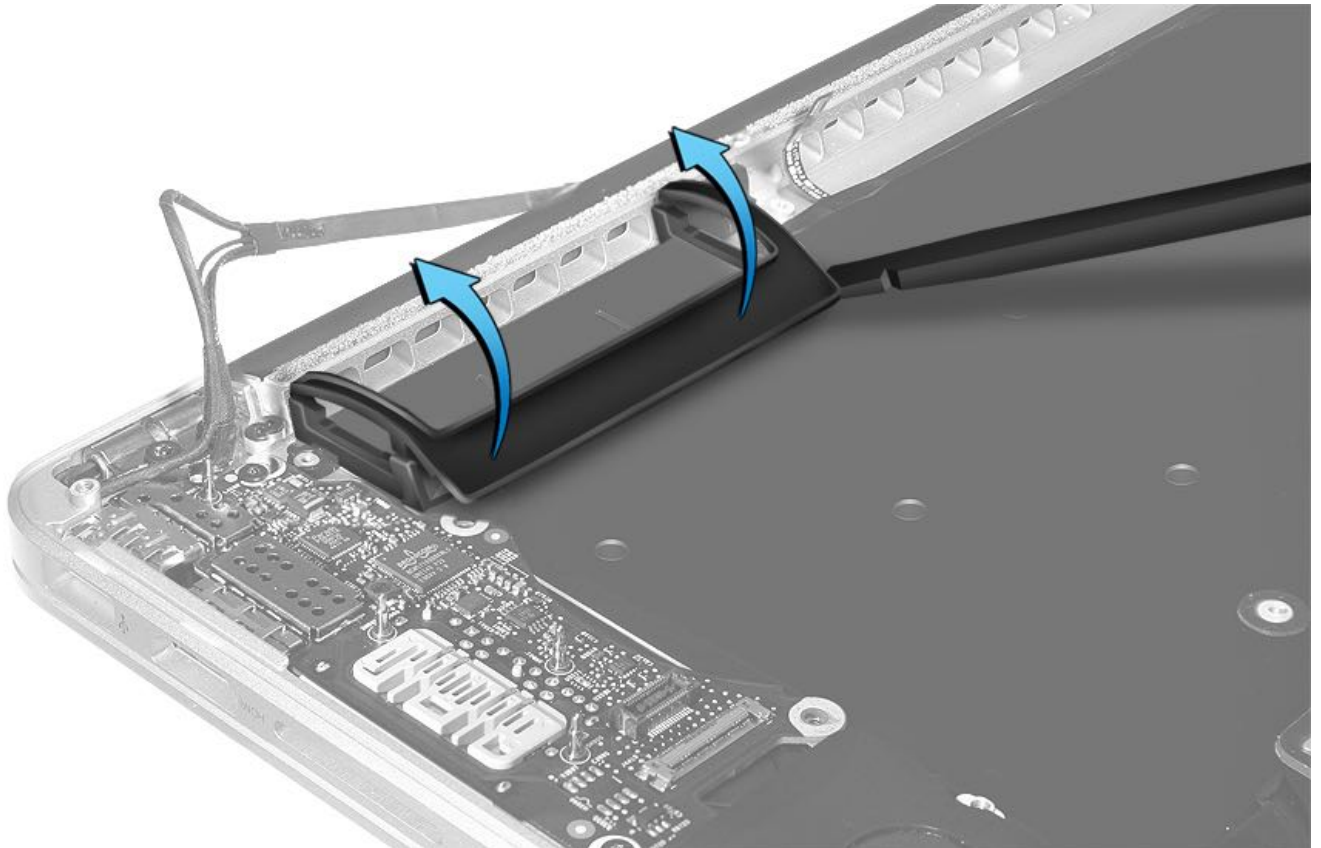
- ESD wrist strap
- Black stick



## Steps For Removal

1. With a black stick or your fingers, lift the fan duct and remove it from the case.

**Note:** For MacBook Pro (Retina, 15-inch, Late 2013, Mid 2014, and Mid 2015), first remove the fan duct mounting screw (923-0682).



## Steps For Reassembly

Reassemble in reverse order of removal steps.

**For MacBook Pro (Retina, 15-inch, Mid 2015) only:** Trackpad performance must be validated after every repair.



# Left Fan Duct

## First Steps

**Important:** This procedure should only be performed by Apple-certified technicians.

Remove:

- [Bottom case](#)
- [SSD card or flash storage](#)
- [I/O flex cable](#) (Mid 2012 and Early 2013)
- [I/O flex cable](#) (Late 2013 and Mid 2014)
- [I/O flex cable](#) (Mid 2015)
- [Right fan](#)
- [Left fan](#)
- [I/O board](#)
- [Logic board](#)

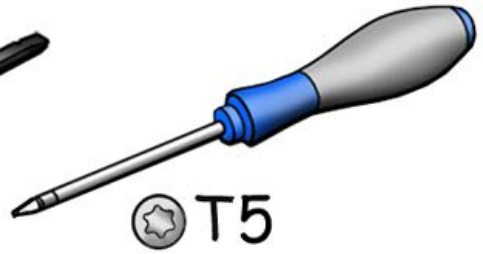


**Warning:** Always [attach the battery cover and disconnect the battery cable](#) immediately after removing the bottom case.



## Tools

- ESD wrist strap
- Black stick
- Torx T5 screwdriver (magnetized)



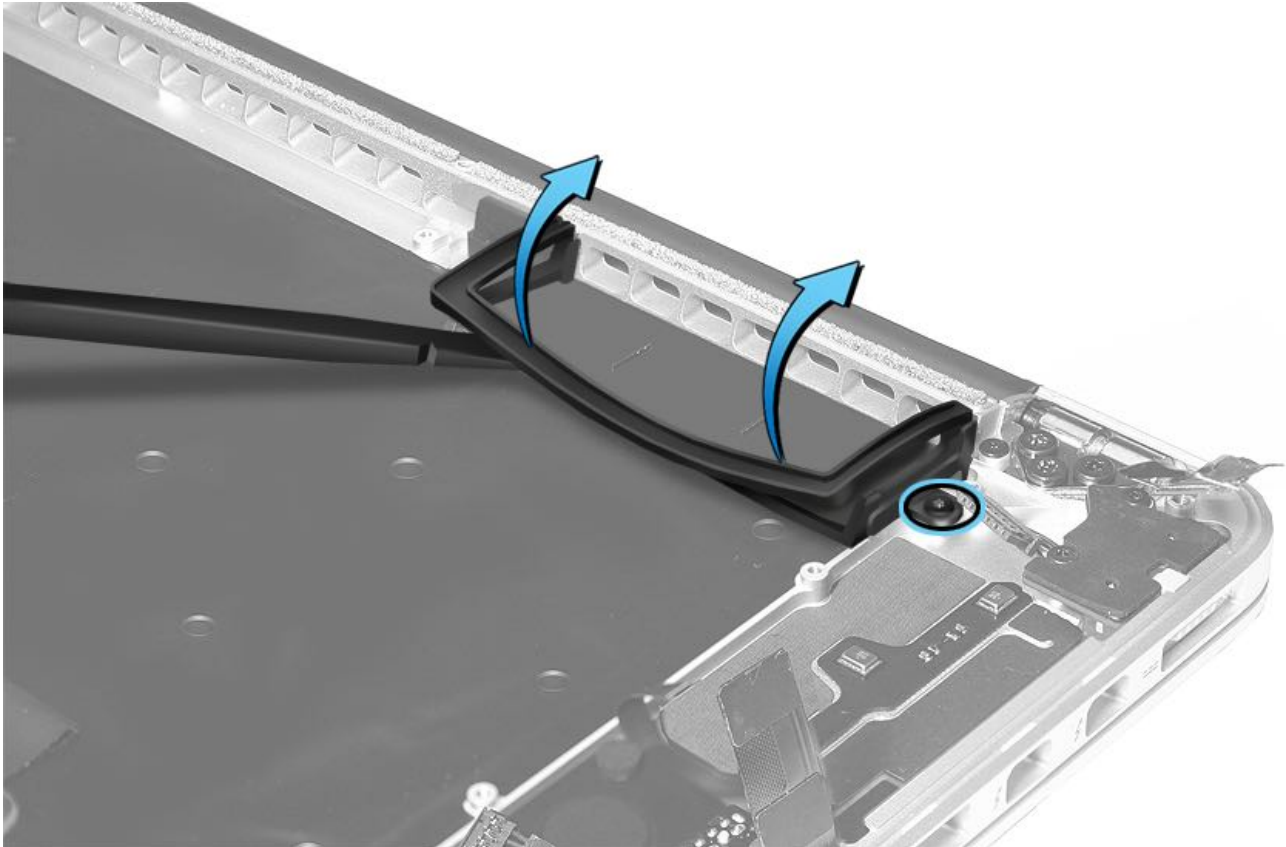
## Steps For Removal

1. Remove one Torx T5 screw:

- 923-0148 (3.6 mm) for MacBook Pro (Retina, 15-inch, Mid 2012 and Early 2013)
- 923-0140 for MacBook Pro (Retina, 15-inch, Late 2013, Mid 2014, and Mid 2015)



2. With a black stick or your fingers, lift the fan duct and remove it from the case.



## Steps For Reassembly

Reassemble in reverse order of removal steps.

**For MacBook Pro (Retina, 15-inch, Mid 2015) only:** Trackpad performance must be validated after every repair.

# Display Assembly and End Caps

## First Steps

**Important:** This procedure should only be performed by Apple-certified technicians.

Remove:

- [Bottom Case](#)



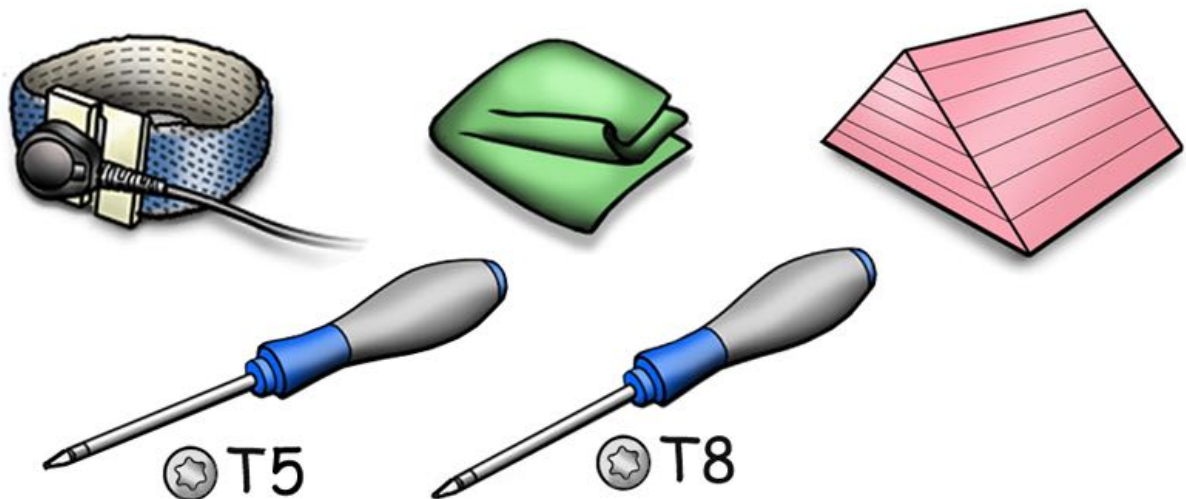
**Warning:** Always [attach the battery cover and disconnect the battery cable](#) immediately after removing the bottom case.



## Tools

- ESD wrist strap
- Clean, soft, lint-free cloth

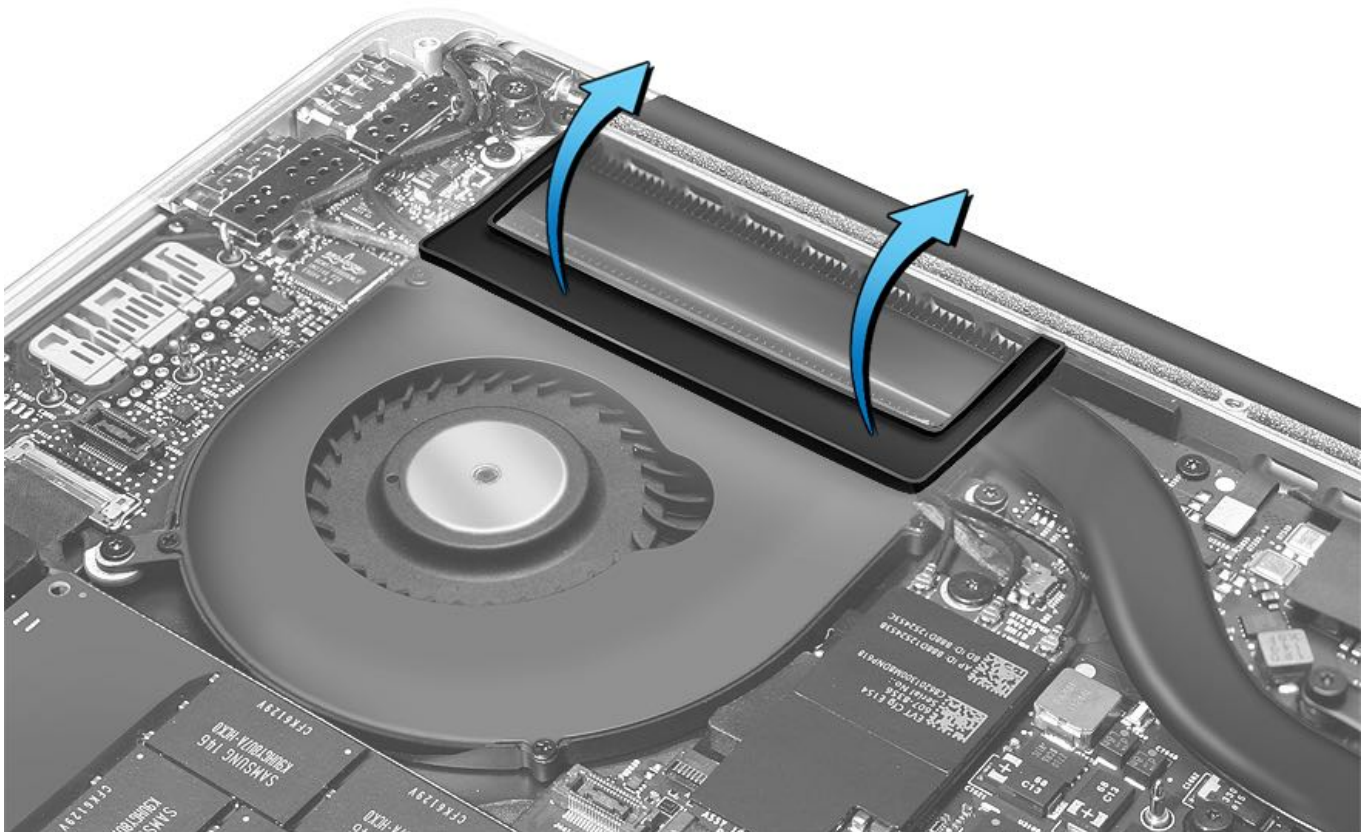
- Foam wedge service fixture
- Torx T5 screwdriver (magnetized)
- Torx T8 screwdriver (magnetized)



## Steps For Removal

**Important:** The right fan duct gasket and cable bundle are attached to the fan with adhesive. Use care when separating them from the fan. If the gasket is damaged or torn, the fan duct must be replaced, which requires removing the logic board.

1. Using your fingers or a black stick, carefully separate the fan duct gasket from fan and rotate the gasket out of the way.



2. Separate the cable bundle from the fan.

**Reassembly Note:** Be sure to return the gasket and cable bundle to their original positions. Press down gently to adhere them to the fan.

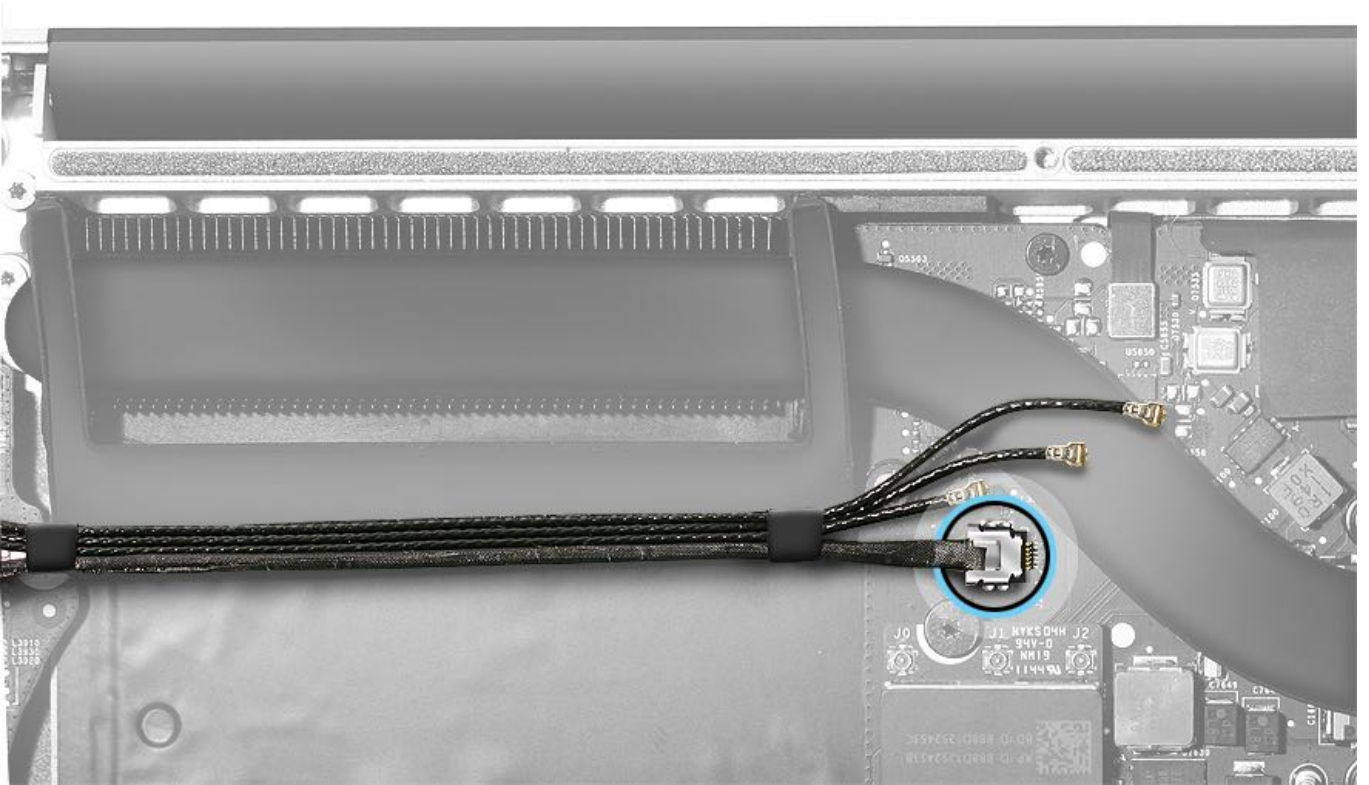




3. Disconnect the antenna cables from the wireless card.

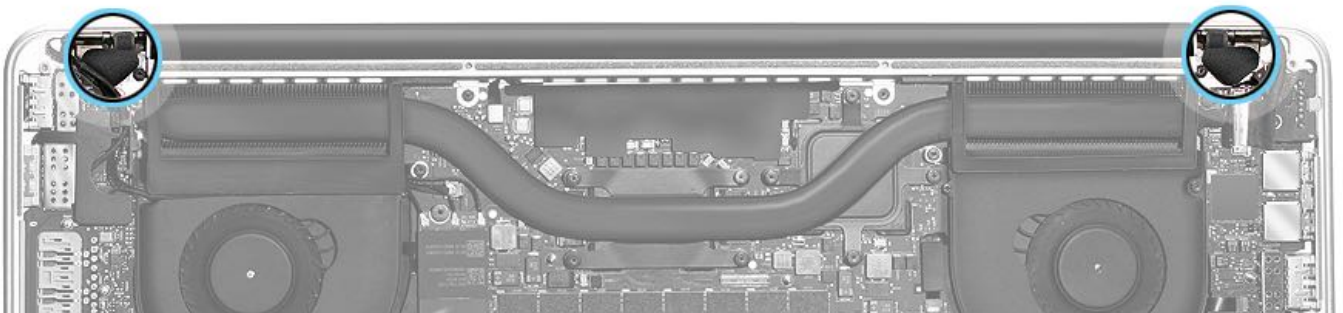


4. Disconnect the camera cable from the logic board and move the cable bundle out of the way.



5. Remove the screw covers from the right and left clutch screws.

**Note:** New screw covers are included with replacement display modules and are available as service parts 923-0108 (right cover) and 923-0109 (left cover).



6. Flip up the lock bar and disconnect the eDP cable from the logic board.

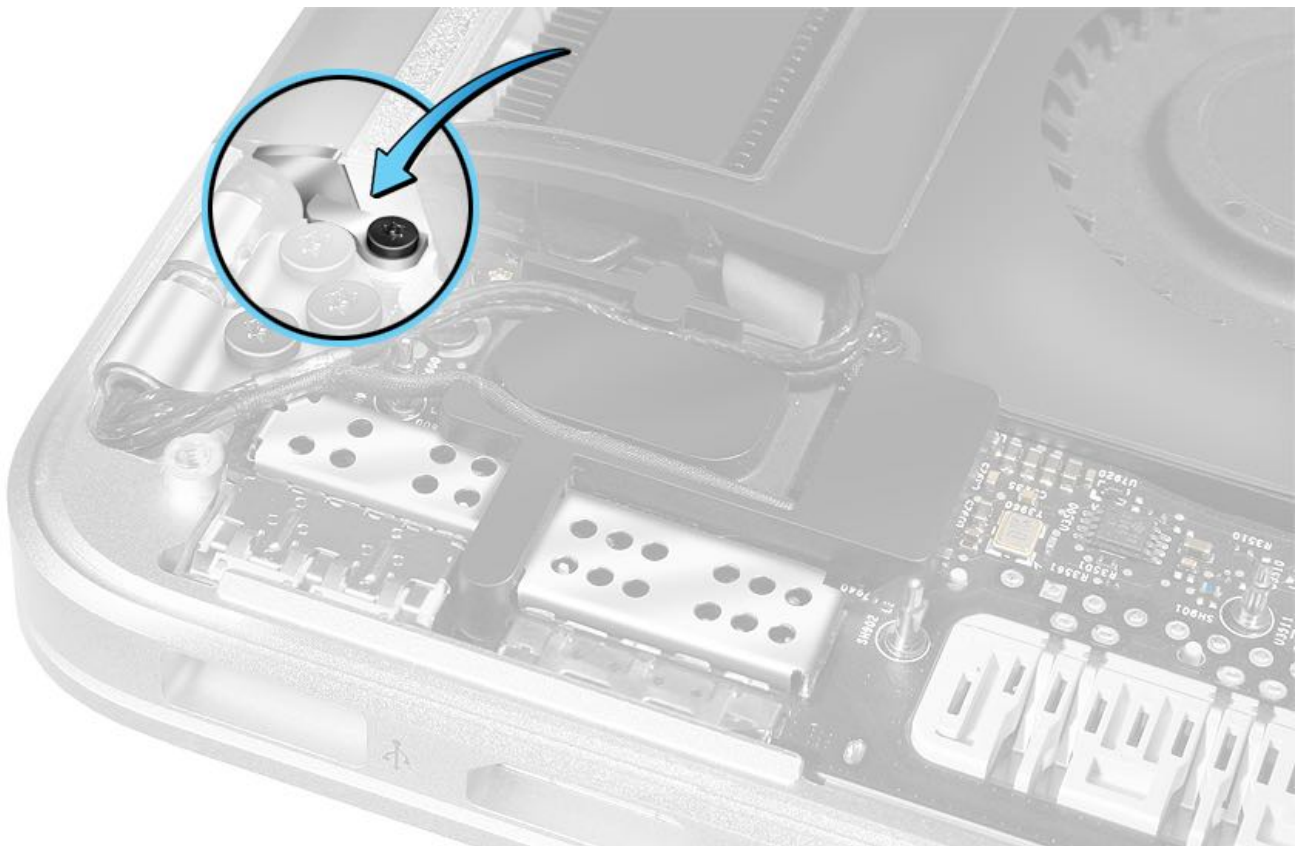


7. Remove one Torx T5 mounting screw from the right display end cap and remove the end cap.

- One 923-0135 (2.6 mm)



**Reassembly Note:** Replacement display modules do not come with end caps. If you are installing a replacement display, you must transfer the end caps to the replacement display. Right and left end caps are also available in a separate service kit (076-1396).



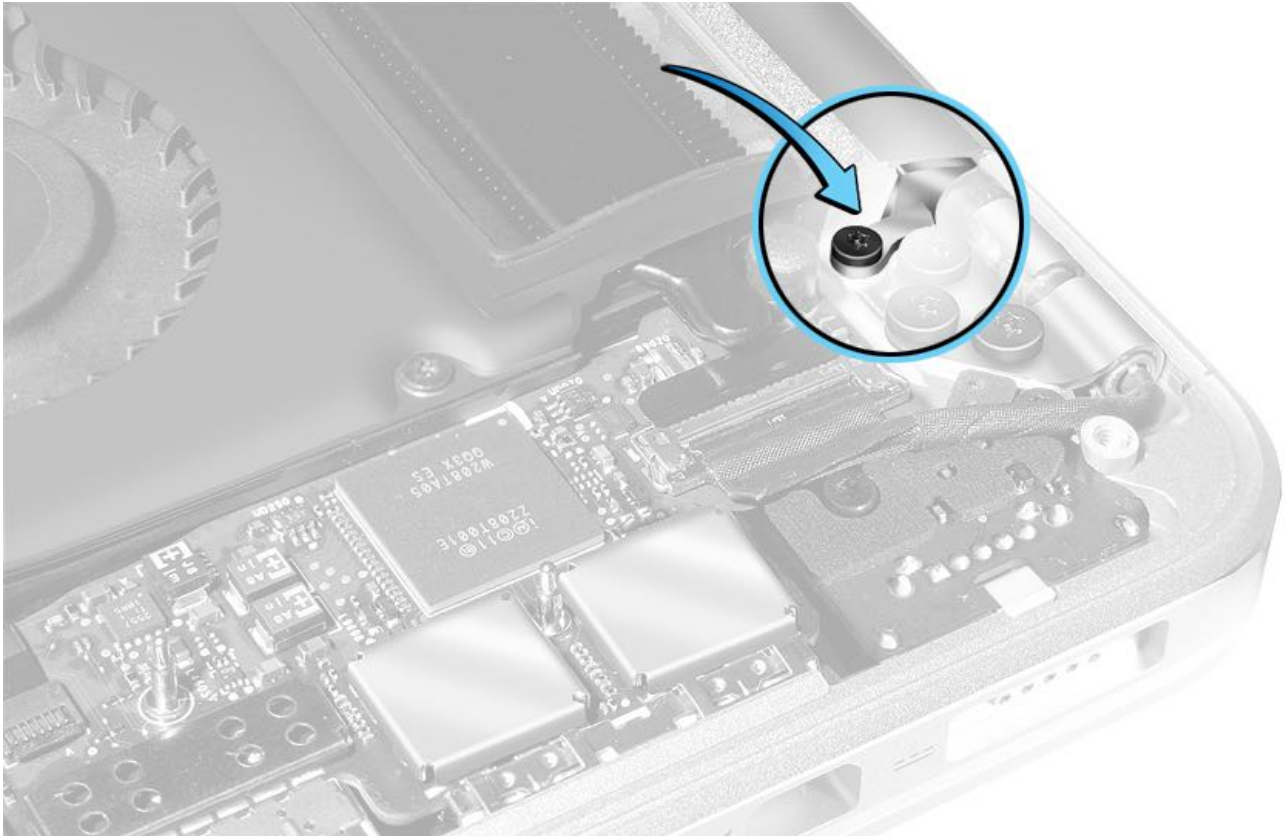


8. Remove one Torx T5 mounting screw from the left display end cap and remove the end cap.

- One 923-0135 (2.6 mm)



**Reassembly Note:** Replacement display modules do not come with end caps. If you are installing a replacement display, you must transfer the end caps to the replacement display. Right and left end caps are also available in a separate service kit (076-1396).



9. Open the display to a 90-degree angle and place it on the foam wedge service fixture (922-8779).

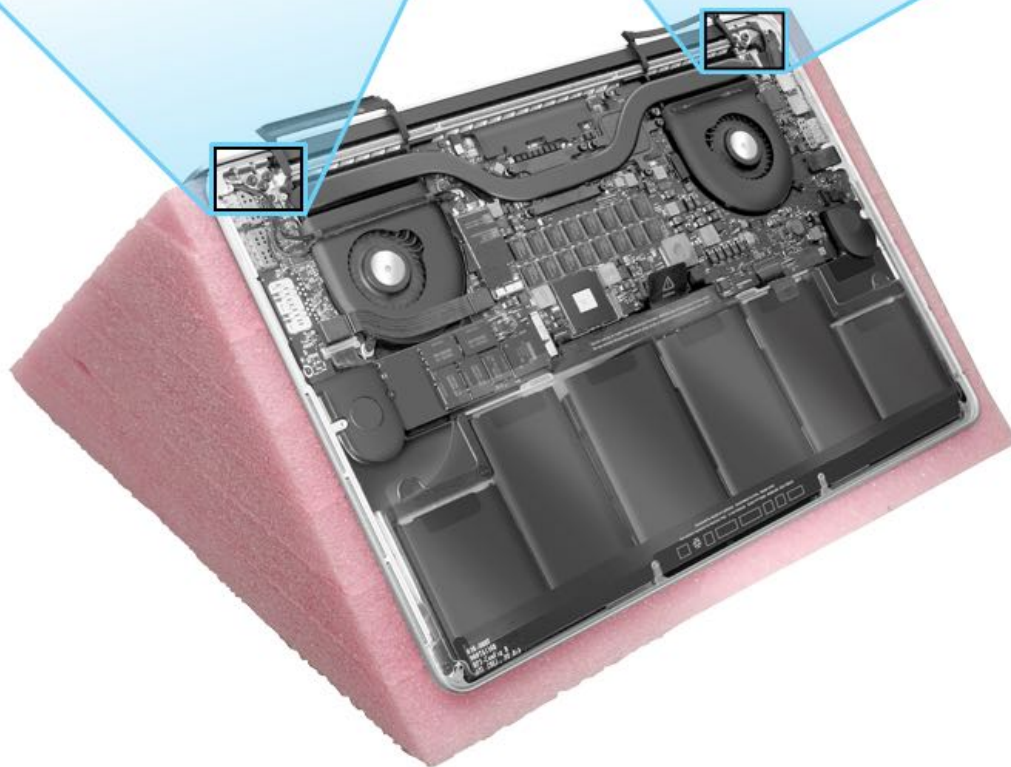
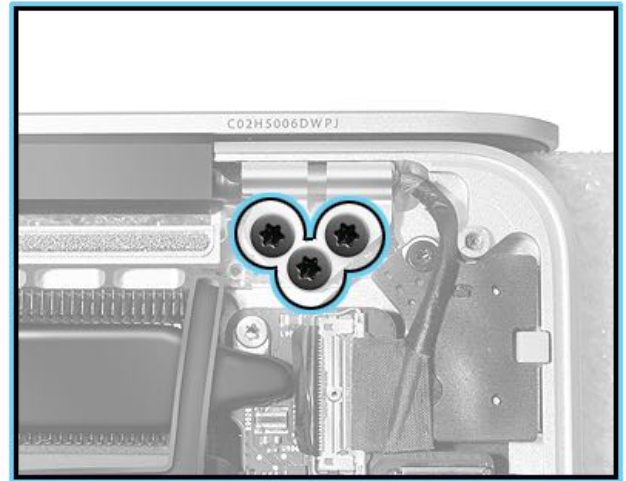
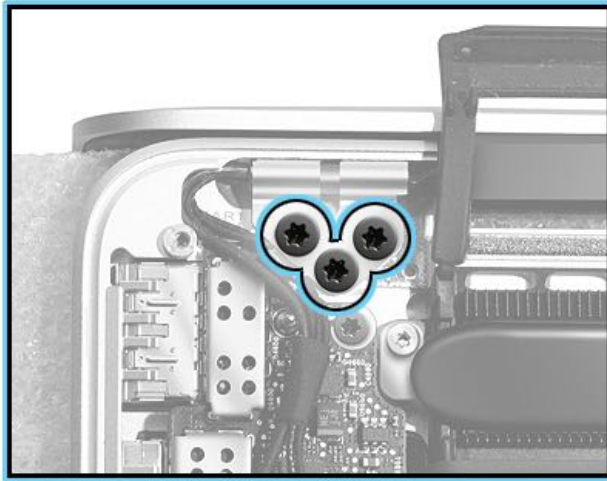
10. Remove six Torx T8 clutch screws:

- Six 923-0139 (3.9 mm)



11. Separate the display assembly from the top case.

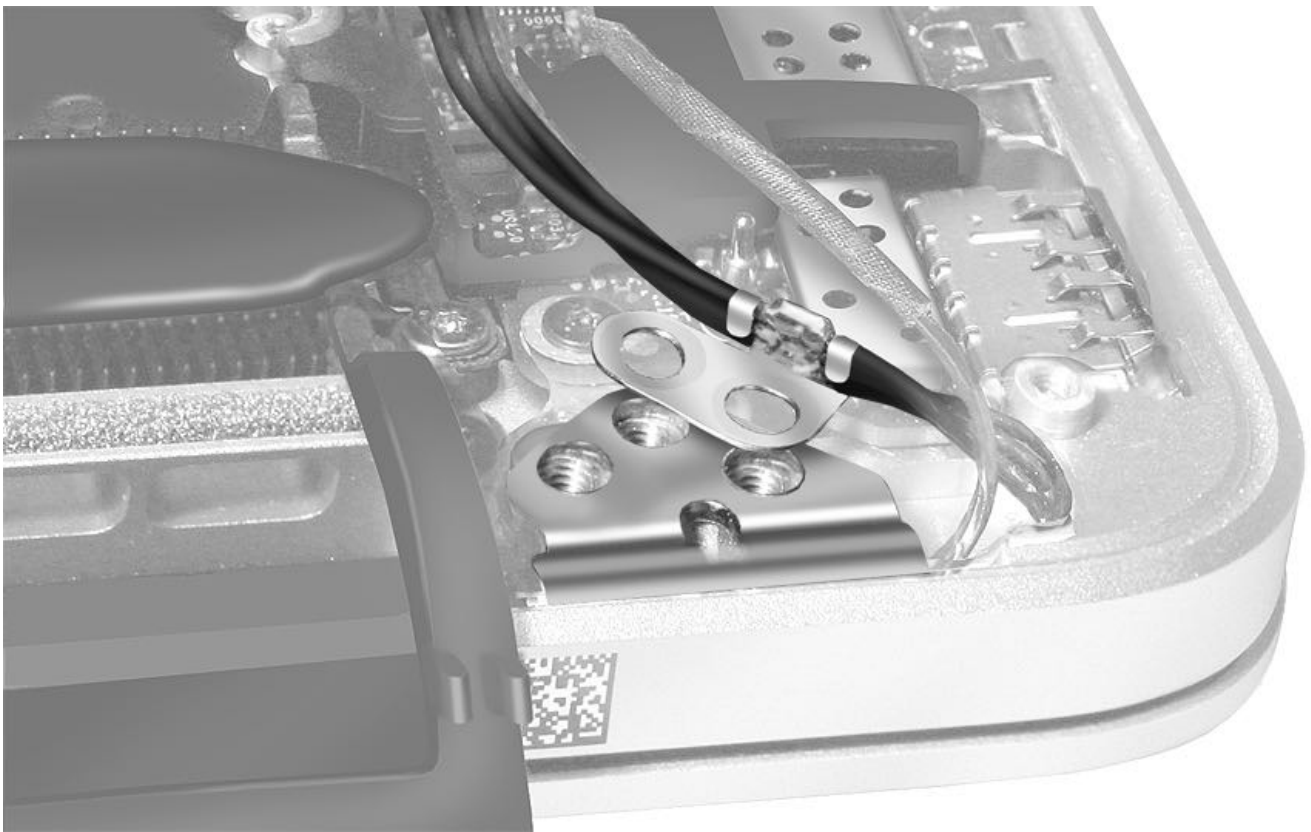




## Steps For Reassembly

**Reassembly Note:** When installing clutch screws, do the following:

1. Align the antenna ground clip on the cable with two screw holes in the right clutch. Loosely install the middle screw.
2. Loosely install the other two right clutch screws, then tighten all three screws.
3. Loosely install the middle left clutch screw.
4. Loosely install the other two left clutch screws, then tighten all three screws.



5. Continue to reassemble in reverse order of removal steps.
6. **For MacBook Pro (Retina, 15-inch, Mid 2015) only:** Trackpad performance must be validated after every repair.

# Top Case Assembly with Battery

## First Steps

**Important:** This procedure should only be performed by Apple-certified technicians.

Remove:

- [Bottom case](#)
- [Trackpad flex cable](#) (Mid 2015)
- [Display assembly](#)
- [SSD card or flash storage](#)
- [I/O flex cable](#) (Mid 2012 and Early 2013)
- [I/O flex cable](#) (Late 2013 and Mid 2014)
- [I/O flex cable](#) (Mid 2015)
- [Right fan](#)
- [Left fan](#)
- [I/O board](#)
- [Logic board](#) with heat sink, I/O coax cable, and wireless card attached
- [Right and left speakers](#)
- [MagSafe 2 board](#)
- [Audio board](#) (Mid 2012 and Early 2013 only)

**Note:** MacBook Pro (Retina, 15-inch, Late 2013, Mid 2014, and Mid 2015) models do not have an audio board. The audio port is integrated into the logic board.



**Warning:** Always [attach the battery cover and disconnect the battery cable](#) immediately after removing the bottom case.

The replacement top case comes with the following parts installed:

- Battery
- Keyboard
- Trackpad
- Microphone
- Fan ducts



## Tools

- ESD wrist strap



## Steps For Removal

With the first steps completed, the top case (with battery, keyboard, trackpad, microphone, and fan ducts) is the remaining component.

**For MacBook Pro (Retina, Mid 2015):** Remove and save the foam gaskets that are located in the corners of the top case.



**Warning:** The battery is part of the top case module. **Do not attempt to remove the battery from the top case.**

**Note:** New screw covers for the display assembly clutch screws are included with replacement top cases and are available as service parts 923-0108 (right cover) and 923-0109 (left cover).

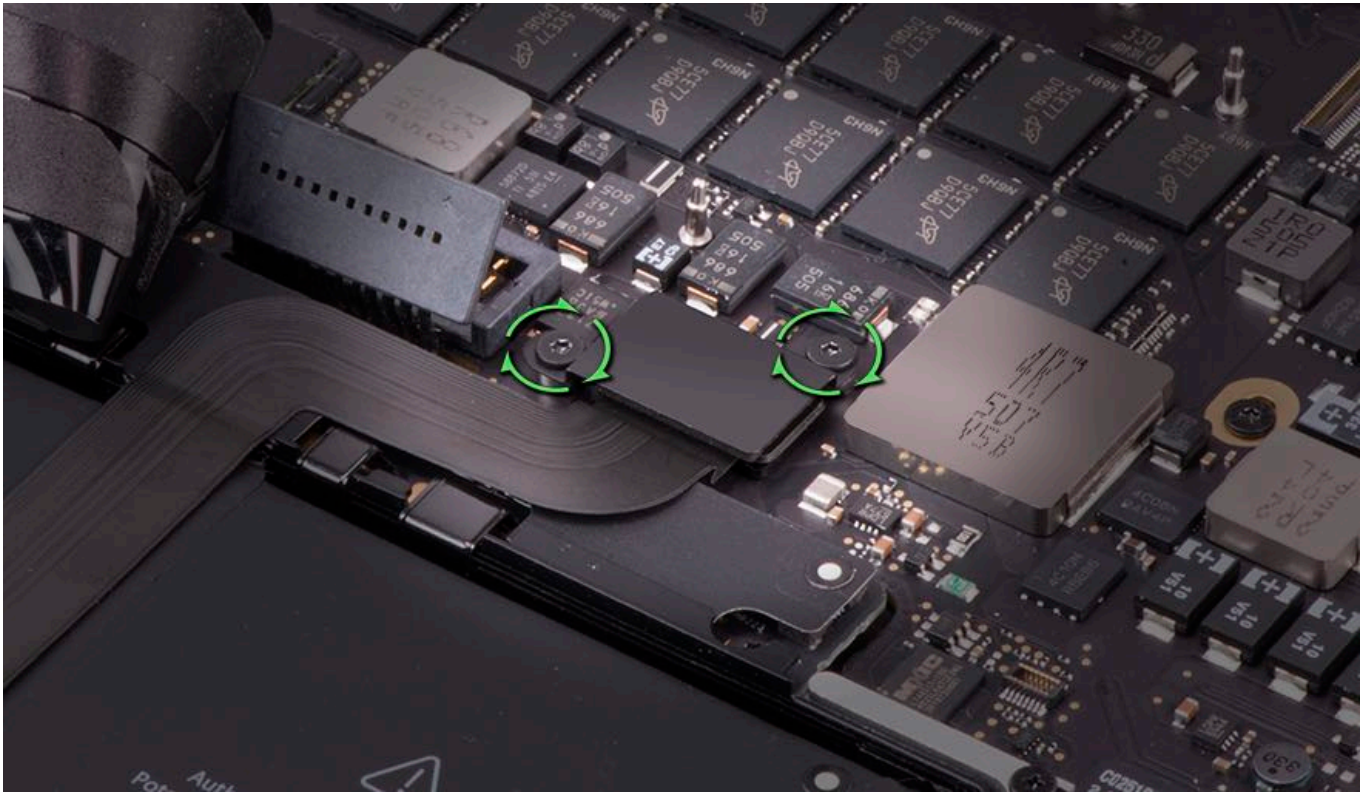
## Steps For Reassembly

**For MacBook Pro (Retina, 15-inch, Mid 2012, Early 2013, Late 2013, Mid 2014):** Reassemble in reverse order of removal steps.

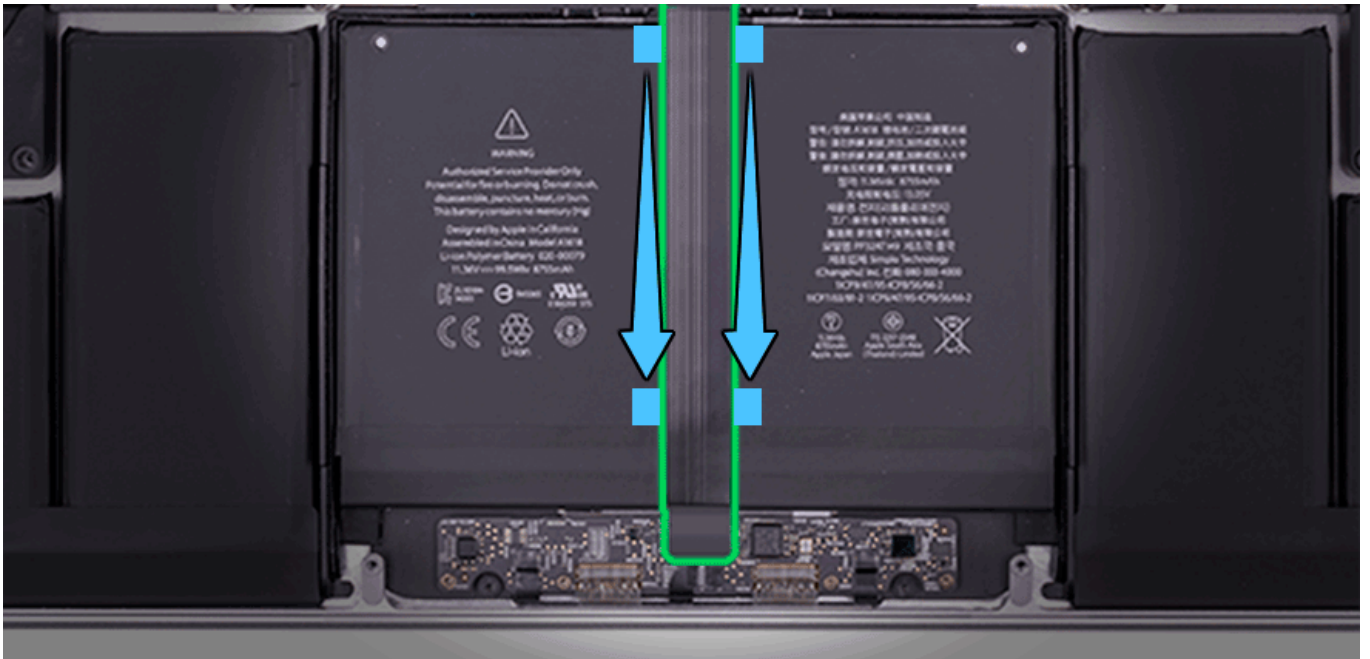


### For MacBook Pro (Retina, 15-inch, Mid 2015):

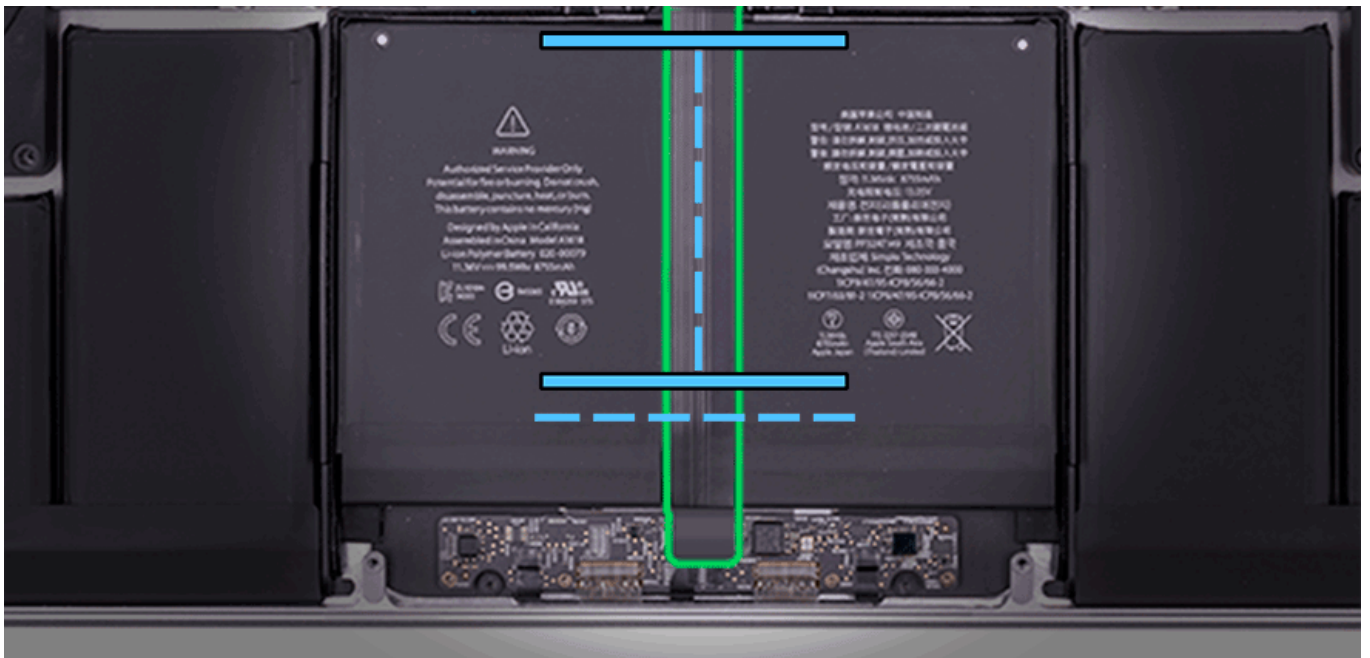
1. The factory preinstalls one end of the trackpad flex cable on replacement top cases. You will need to connect the other end of the flex cable to the logic board connector during reassembly.
2. Remove the orange band around the trackpad flex cable. It is only there to protect the cable from bending during shipping.
3. Once the logic board is installed, connect the trackpad flex cable to the logic board. **Caution:** Be sure not to bend the flex cable, as multiple bends can degrade the cable.



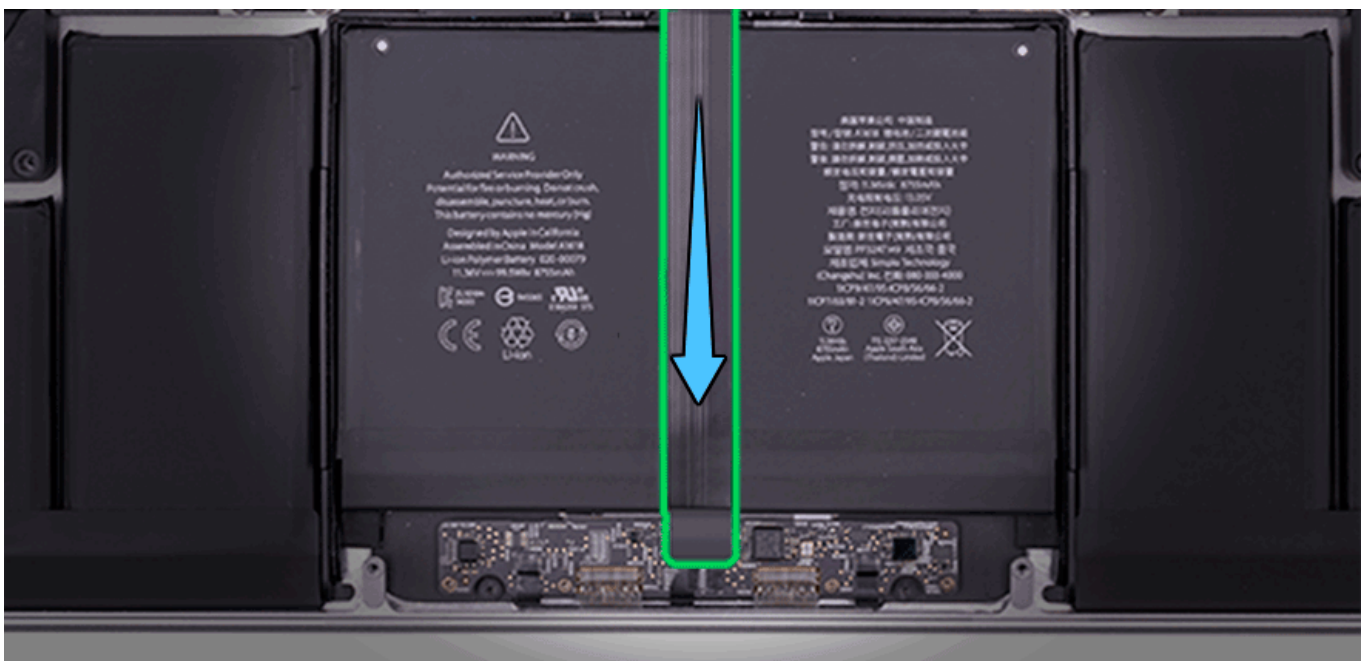
4. Pull the two blue pull-tabs (on the underside of the flex cable) in a downward motion to expose the adhesive backing on the underside of the cable.



5. To secure the cable to the battery, start at the top of the cable and carefully apply light pressure with your finger. Press in the middle along the vertical dotted line. Do not press on the lower end of the cable below the horizontal dotted line.

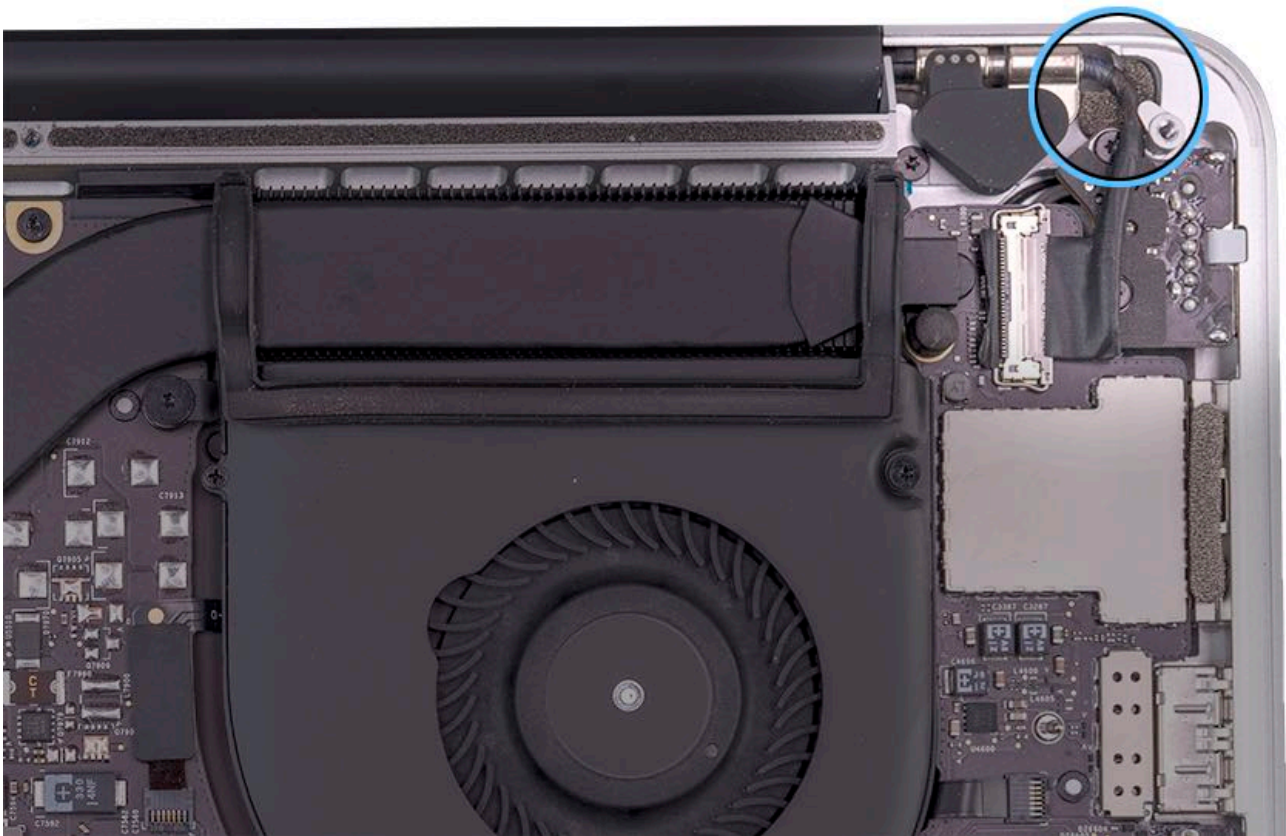


6. Any excess flex cable length should be directed toward the trackpad board, not toward the logic board.



7. Continue to reassemble in reverse order of removal steps.

8. Reinstall the two foam gaskets in both corners of the top case.

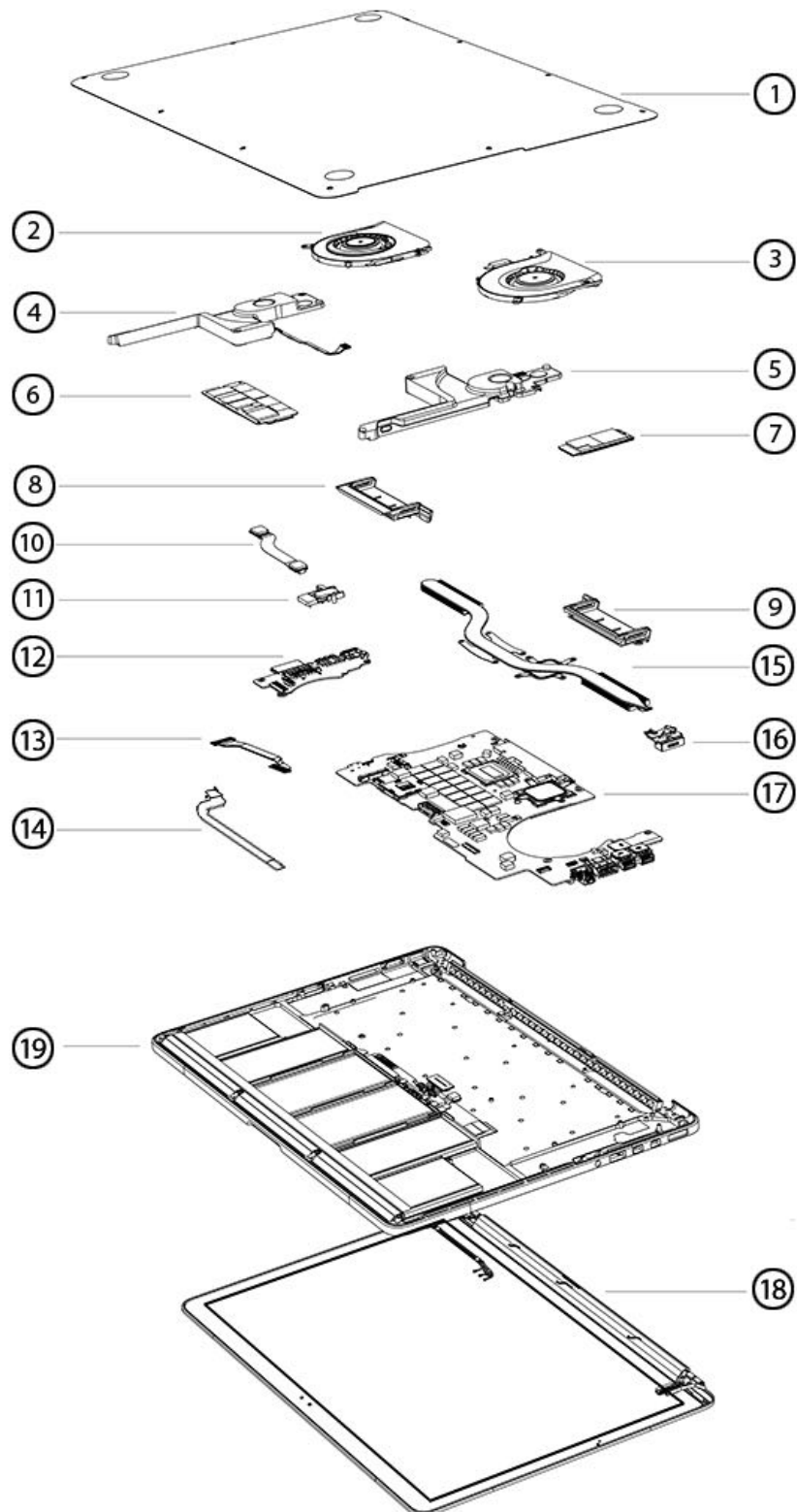


**For MacBook Pro (Retina, 15-inch, Mid 2015) only:** Trackpad performance must be validated after every repair.



# Exploded View

## Exploded View for MacBook Pro (Retina, 15-inch, Mid 2015)



### 1. Bottom Case

- 923-00544 (Integrated GPU)
- 923-00545 (Discrete GPU)

### 2. Right Fan

- 923-00536

### 3. Left Fan



- 923-00537

#### **4. Right Speaker** (Speakers are replaced as a pair)

- 923-00534

#### **5. Left Speaker** (Speakers are replaced as a pair)

- 923-00534

#### **6. Flash Storage**

- 661-02529 - 256GB
- 661-02530 - 512GB
- 661-02531 - 1TB

#### **7. Wireless Card**

- 661-8143 - US / Canada / Latin America

**Note:** Regional wireless cards have the same base part number, but include a language code prefix (for example, J661-8143). Prefixes are:

- J: Japanese
- KH: Korean
- PA: PAL Pacific
- Z: English International
- ZM: International

#### **8. Right Fan Duct**

- 923-0672

#### **9. Left Fan Duct**

- 923-0673

#### **10. I/O Flex Cable**

- 076-00085 (Cable and bracket kit)
- 923-00543 (Bracket 5pk)

#### **11. I/O Board Cable Guide**

- 923-0674

#### **12. I/O Board**

- 661-8312

#### **13. I/O Coax Cable**

- 923-0666

#### **14. IPD Flex Cable**

- 923-00541

#### **15. Heat Sink**

- 076-00083 (Integrated GPU)
- 076-00084 (Discrete GPU)

#### **16. MagSafe 2 Board**

- 923-00535

#### **17 Logic Board**

- 661-02524 - 2.2GHz, 16GB
- 661-02525 - 2.5GHz, 16GB
- 661-02526 - 2.5GHz, 16GB, Discrete GPU

- 661-02527 - 2.8GHz, 16GB
- 661-02528 - 2.8GHz, 16GB, Discrete GPU

## 18. Display Assembly

- 661-02532

## 19. Top Case Assembly with Battery

- 661-02536

**Note:** Out-of-Warranty battery replacement requires the whole top case with battery to be replaced.

- 661-02537 Battery Replacement, Top Case Assembly with Battery

**Note:** Regional top cases have the same base part number, but include a language code prefix (for example, C661-02536). Prefixes are:

- AB: Arabic
- B: British
- BG: Bulgarian
- C: Canadian
- CR: Croatian
- CZ: Czech
- D: German
- DK: Danish
- E: Spanish
- F: French
- GR: Greek
- H: Norwegian
- HB: Hebrew
- J: Japanese
- KH: Korean
- MG: Hungarian
- N: Dutch
- PO: Portuguese
- RO: Romanian
- RS: Russian
- S: Swedish
- SF: Swiss French
- SL: Slovak
- T: Italian
- TA: Taiwanese
- TH: Thai
- TQ: Turkish
- TU: Turkish
- Z: English International

### Not Shown:













- Battery Cover: 923-0706
- Display End Cap Kit: 076-1396
- Clutch Screw Cover, Right: 923-0108
- Clutch Screw Cover, Left: 923-0109
- Adapter, 85W: 661-00682












**Note:** Regional adapters have the same base part number, but include a language code prefix (for example, PA661-00682). Prefixes are:

- PA: PAL Pacific
- AR: Argentina
- HN: India
- MY: Malay
- LA: Latin America

# Screw Chart

## Screw Chart for MacBook Pro (Retina, 15-inch, Mid 2012, Early 2013, Late 2013, Mid 2014, Mid 2015)

<p><b>922-9651</b> Torx T5</p>  <p>Wireless card (1)</p>	<p><b>923-0131</b> (Mid 2012 and Early 2013 only) <b>076-00003</b> (Late 2013, Mid 2014, and Mid 2015) Pentalobe</p>  <p>Bottom case (8)</p>	<p><b>923-0132</b> (Mid 2012 - Mid 2014) <b>923-00540</b> (Mid 2015) Pentalobe</p>  <p>Bottom case (2)</p>
<p><b>923-0162</b> Torx T5 Long</p>  <p>Right fan (1) Left fan (1)</p>	<p><b>923-0133</b> Torx T5 Long, shoulder</p>  <p>Right fan (1) Left fan (1)</p>	<p><b>923-0149</b> Torx T5 Short</p>  <p>Right fan (1), thick head</p>
<p><b>923-0158</b> Torx T5</p>  <p>Left fan (1), thin head</p>	<p><b>923-0144</b> Torx T5</p>  <p>MagSafe 2 board (2)</p>	<p><b>923-0142</b> Torx T5</p>  <p>Audio board (2)</p>
<p><b>923-0138</b> Torx T5</p>  <p>Speaker (2), front of board</p>	<p><b>923-0146</b> Torx T5</p>  <p>Speaker (2), center of board</p>	<p><b>923-0143</b> Torx T5</p>  <p>Speaker (2), back of board</p>

<b>923-0135</b> Torx T5  Display end caps (2) I/O board (2)	<b>923-0139</b> Torx T8  Display hinge clutch (6)	<b>923-0140</b> Torx T5  Left fan duct (1) Logic board (1)
<b>923-0144</b> Torx T5 Medium  Logic board (1)	<b>923-0145</b> Torx T5 Long  Logic board (2)	<b>923-0141</b> Torx T5  Heat sink (6), thick head
<b>923-0159</b> Torx T5  Heat sink (2), thin head	<b>923-0147</b> <b>923-0681</b> (Late 2013, Mid 2014, and Mid 2015) Torx T5  Heat sink (1), ground cap	<b>923-0148</b> <b>923-00538</b> (Mid 2015 only) Torx T5  Heat sink (1), nickel
<b>923-0161</b> Torx T5  SSD card or flash storage (1)	<b>923-0682</b> (Late 2013 and Mid 2014 only) Torx T5  <b>Note:</b> No part image available.  Right fan duct (1)	<b>923-00523</b> (Mid 2015 only) Torx T5  Trackpad flex cable (2), I/O board flex cable (4)



**923-00546** (Mid 2015 only)  
Torx T5



Heat sink (Mid 2015 only) (4 integrated GPU,  
4 discrete GPU)

**923-00554** (Mid 2015 only)  
Torx T5



Heat sink (Mid 2015 only) (4 discrete  
GPU)

# Screw Location Diagrams

## Screw Location Diagrams for MacBook Pro (Retina, 15-inch, Mid 2012, Early 2013, Late 2013, Mid 2014, Mid 2015)

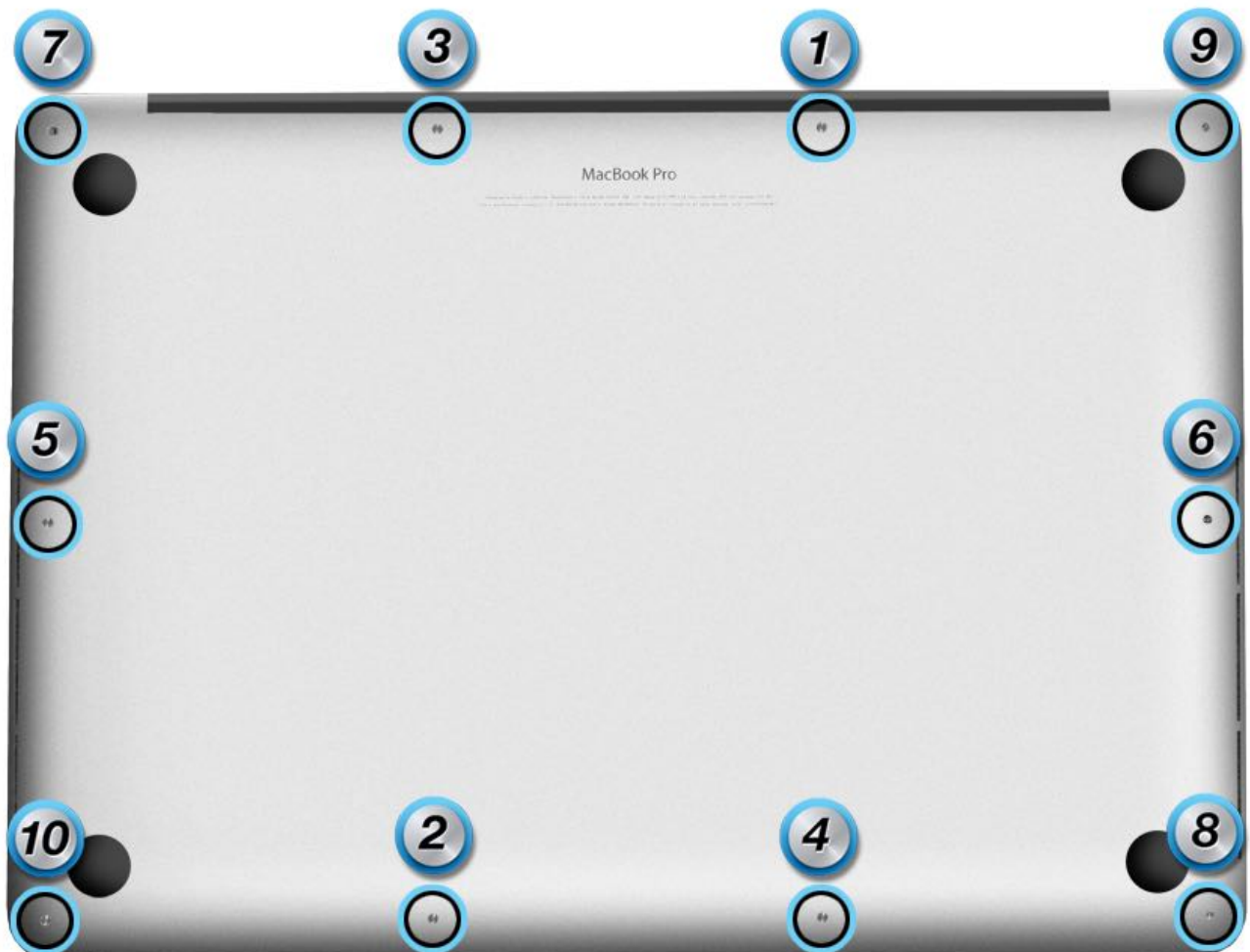
**Note:** All screw sizes are approximate and represent the total length of the screw.

### Bottom Case

- Mid 2012 - Mid 2014: Two 923-0132 (2.18 mm) at positions 1 and 3 in the graphic.
- Mid 2015: Two 923-00540 (2.18 mm) at positions 1 and 3 in the graphic.

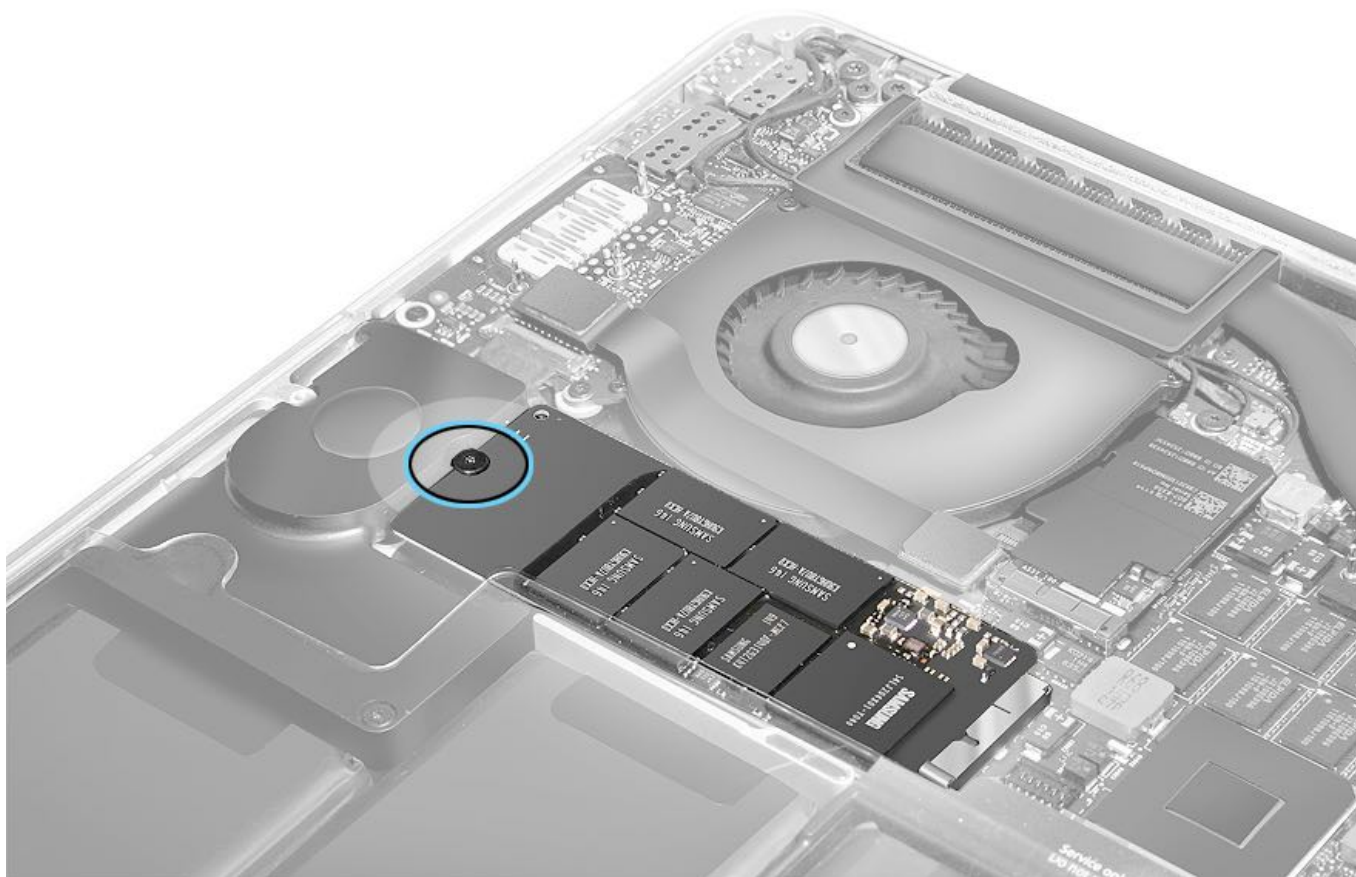


- Mid 2012 and Early 2013: Eight 923-0131 (3.06 mm) at positions 2 and 4–10 in the graphic.
- Late 2013, Mid 2014, and Mid 2015: Eight from Apple screw kit 076-00003 (3.06 mm) at positions 2 and 4–10 in the graphic.



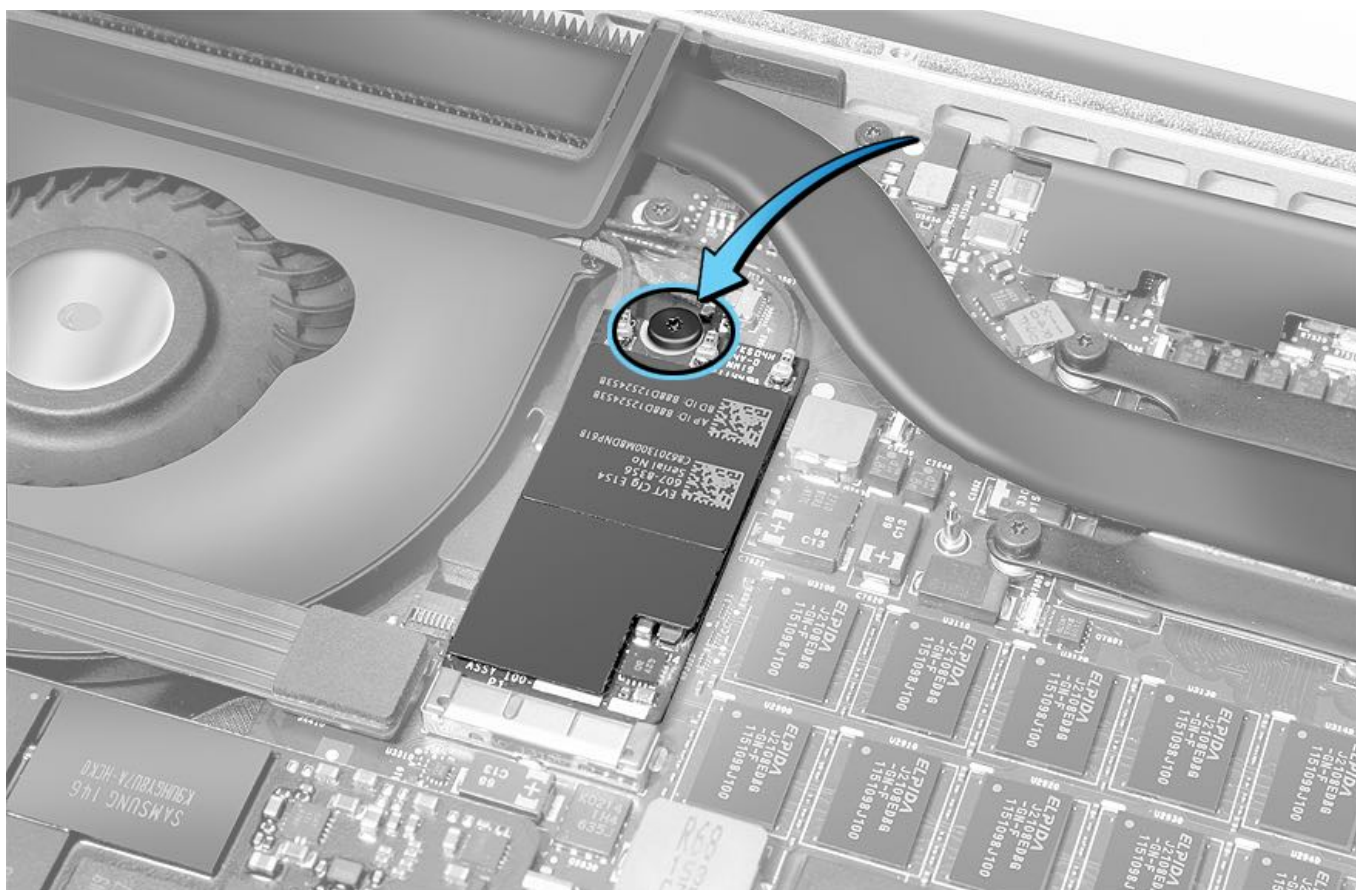
## Flash Storage

- One 923-0161 (1.7 mm)



## Wireless Card

- One 922-9651 (2.0 mm)



## Right Fan

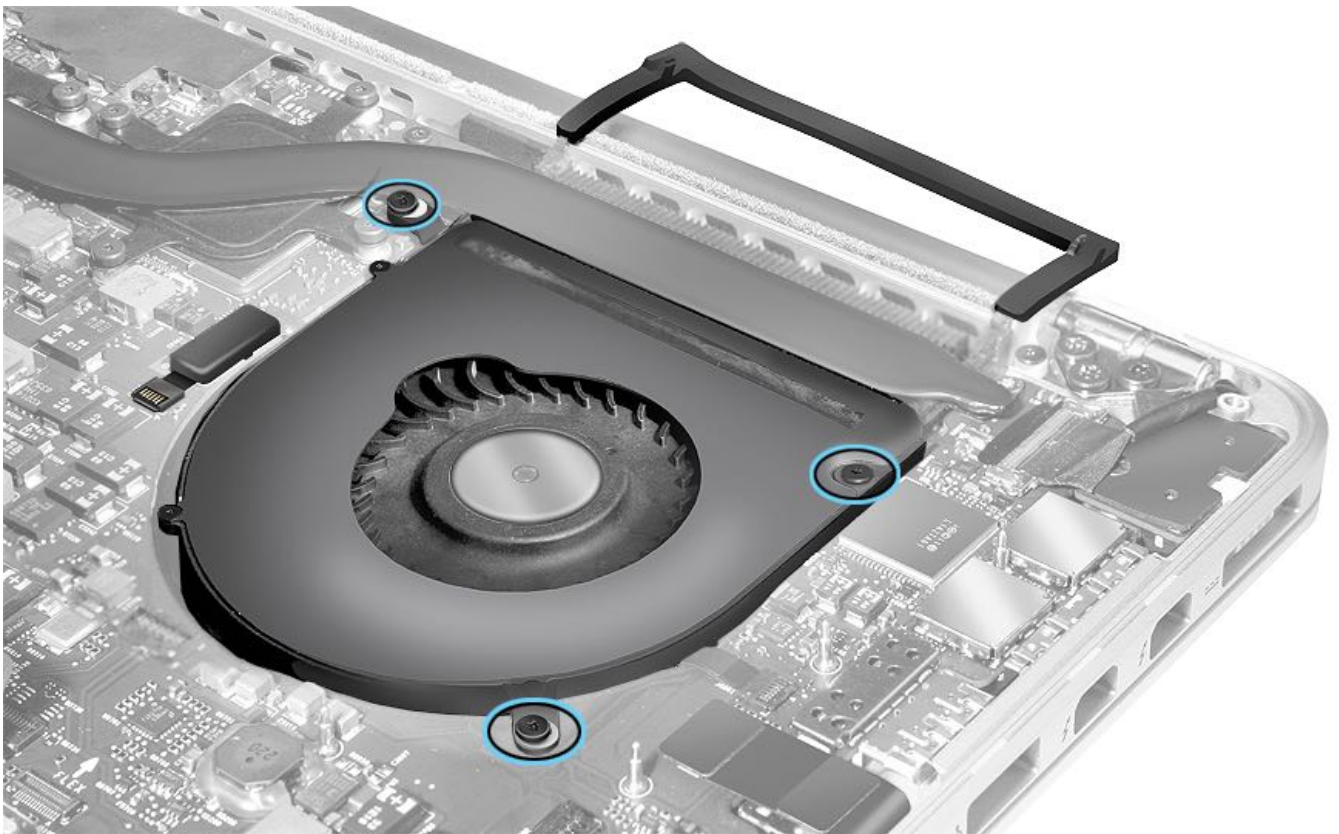
- One 923-0149 (3.90 mm) (short, top right)
- One 923-0133 (5.04 mm) (long, shoulder, top left)
- One 923-0162 (4.38 mm) (medium, bottom)



## Left Fan

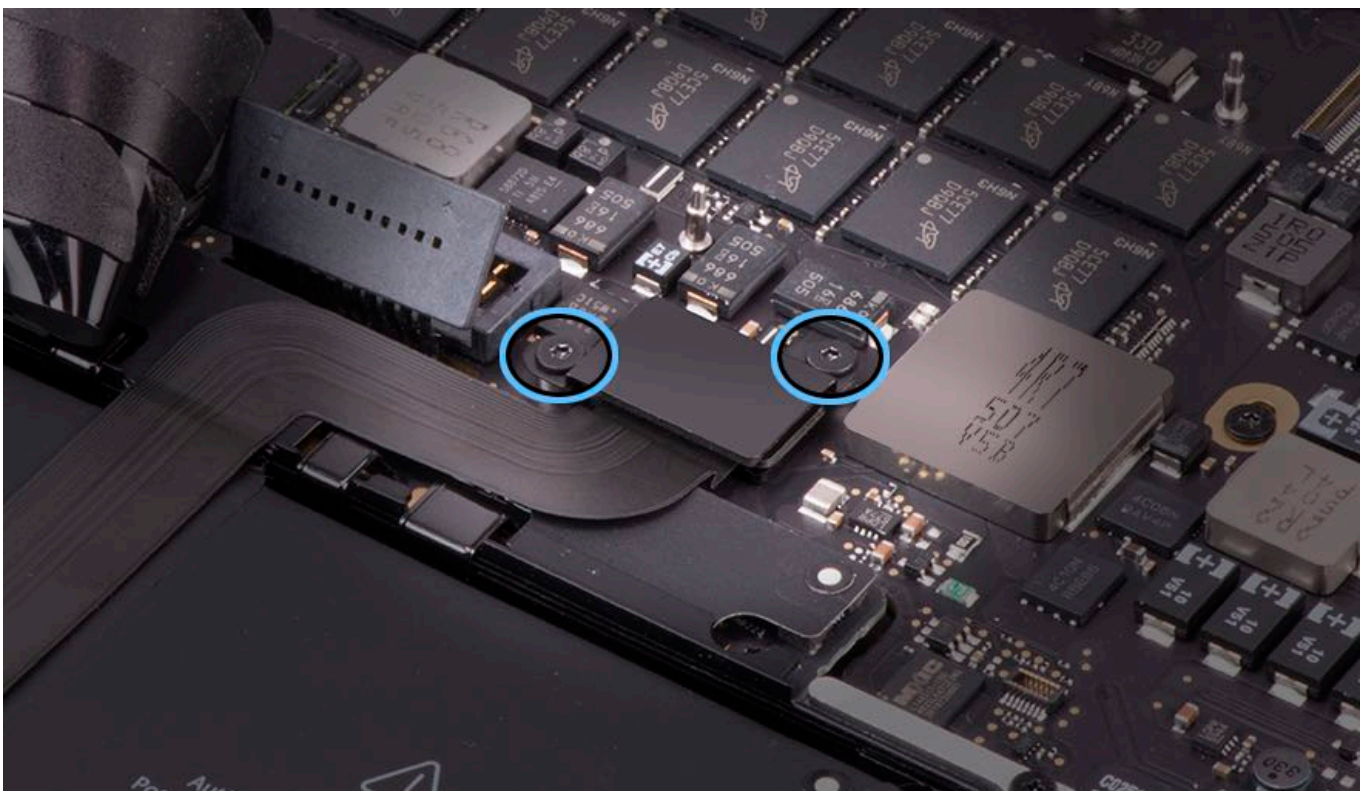
- One 923-0158 (3.6 mm) (short, thin head, top left)
- One 923-0133 (5.04 mm) (long, shoulder, top right)
- One 923-0162 (4.38 mm) (medium, bottom)





#### Trackpad Flex Cable

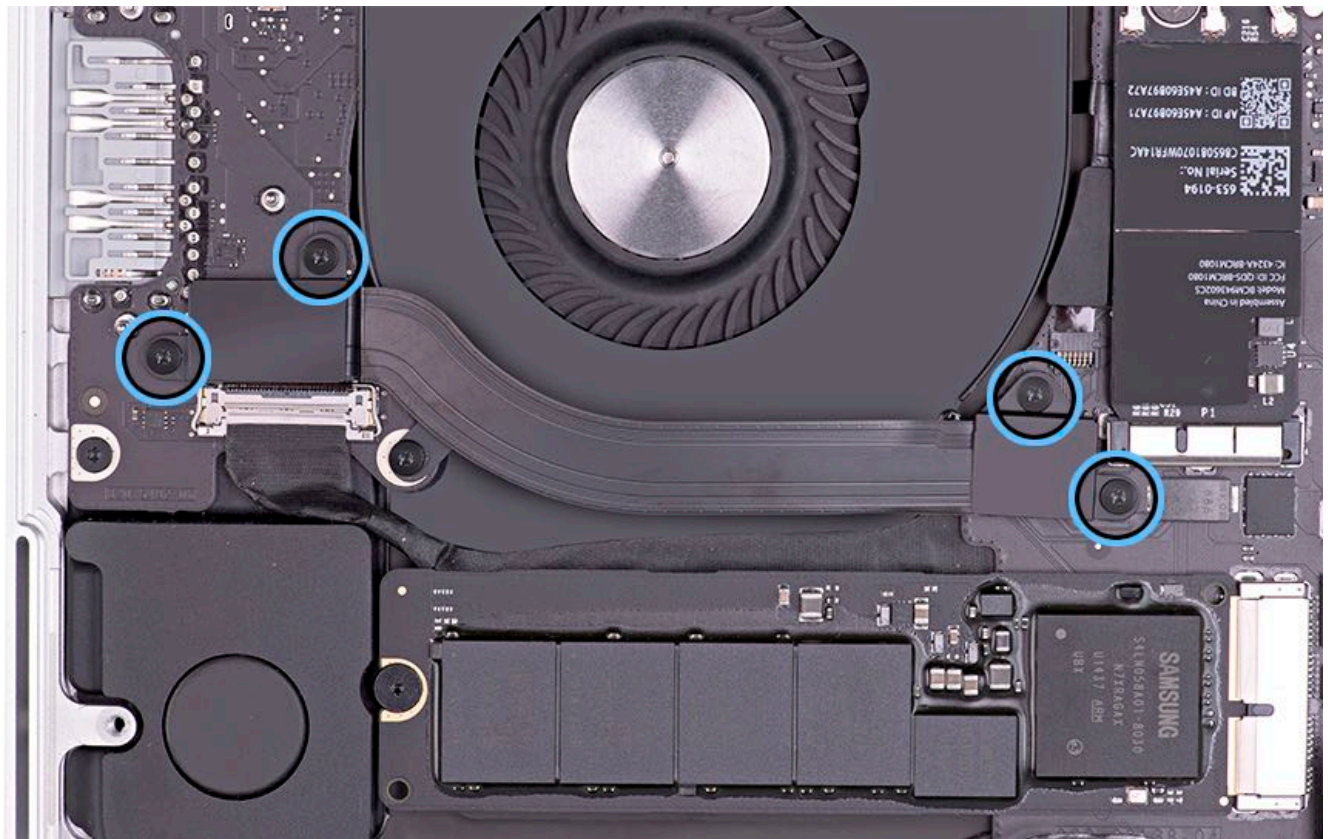
- Two 923-00523 (2.12 mm)



#### I/O Board Flex Cable

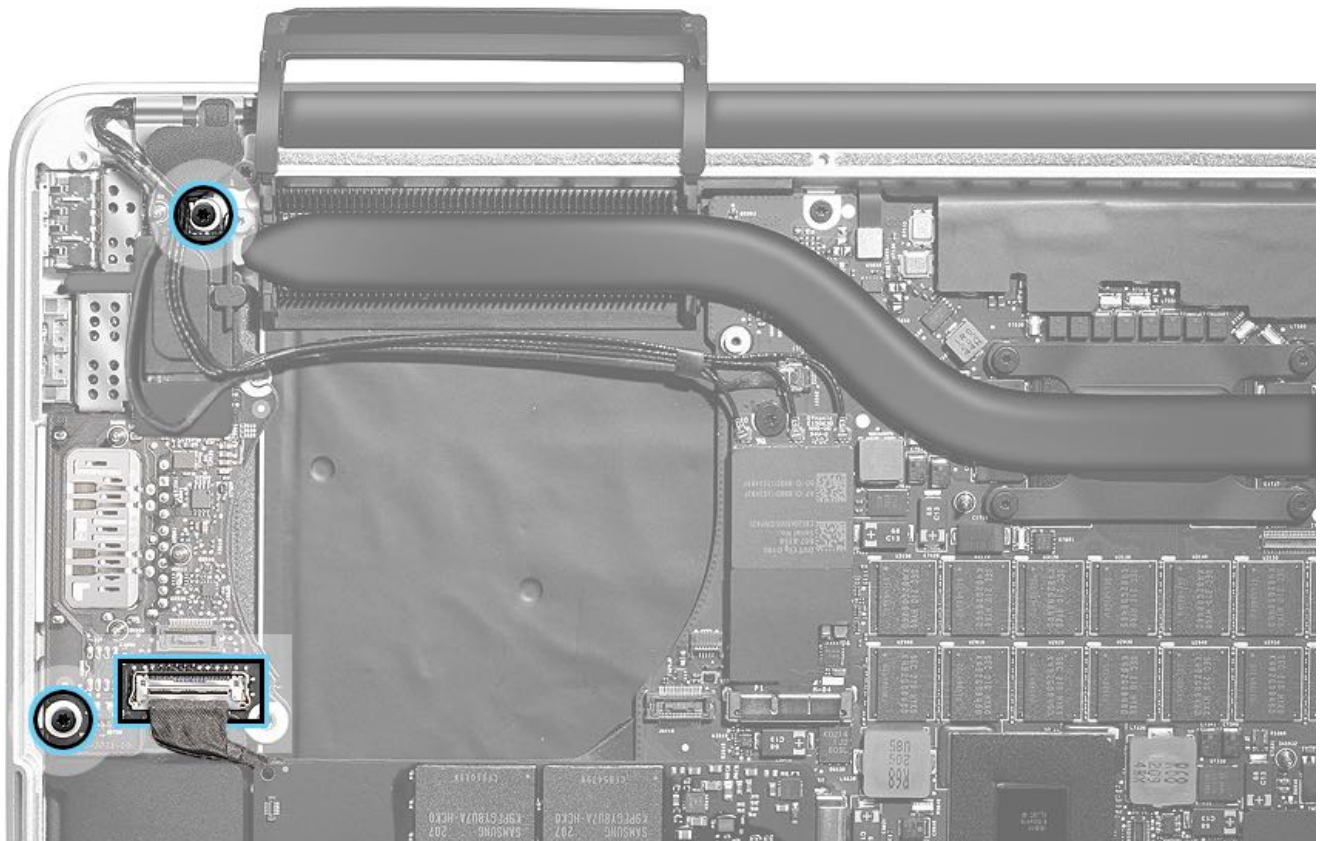
- Four 923-00523 (2.12 mm)





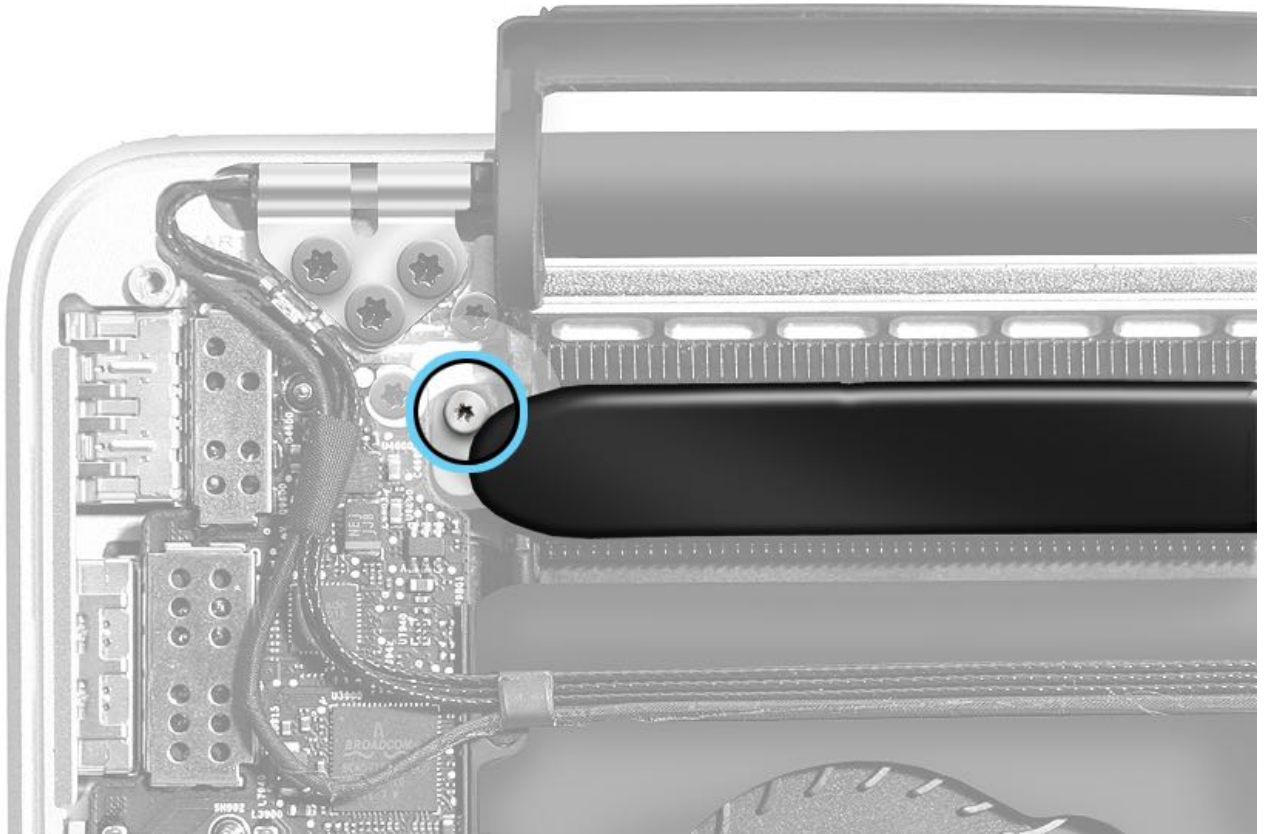
#### I/O Board

- Two 923-0135 (2.6 mm)

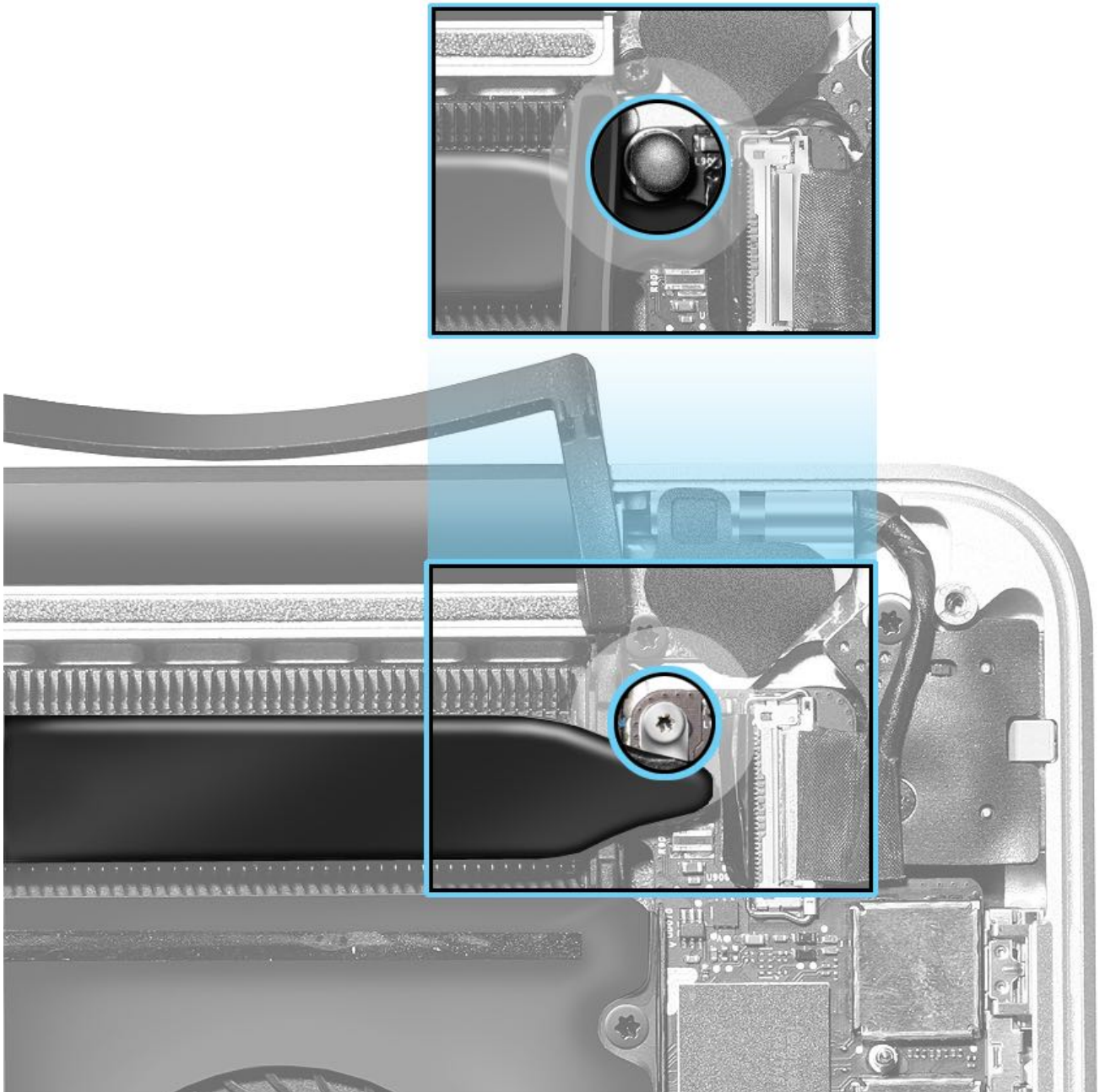


#### Logic Board

- One 923-0148 (2.95 mm)
- One 923-00538 (2.9 mm) (Mid 2015 only)



- Mid 2012 and Early 2013: One 923-0147 (3.6 mm)
- Late 2013, Mid 2014, and Mid 2015: One 923-0681 (3.64 mm)



#1 and #2 screws

- Two 923-0145 (4.95 mm)

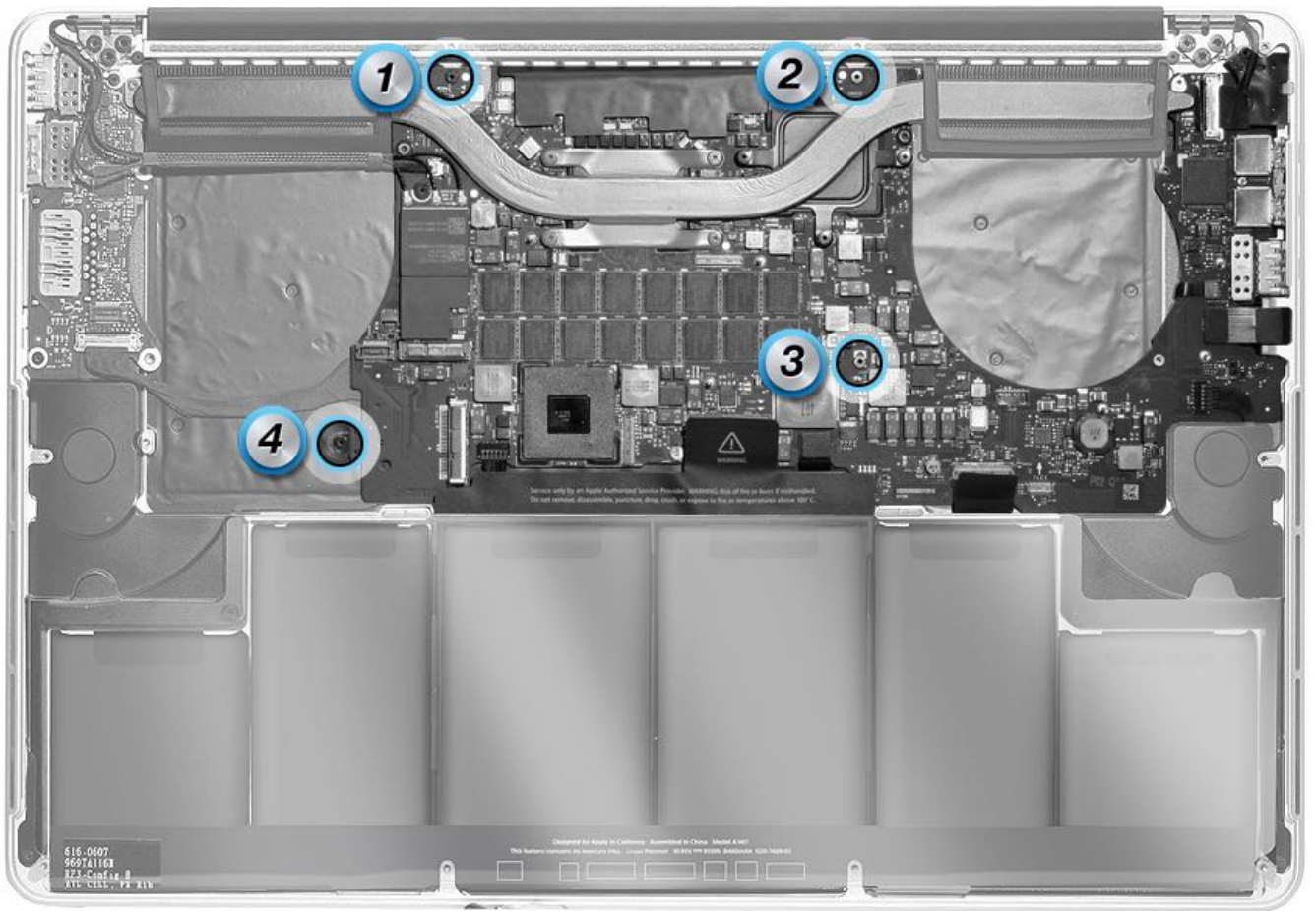
#3 screw

- One 923-0144 (2.95 mm)

#4 screw

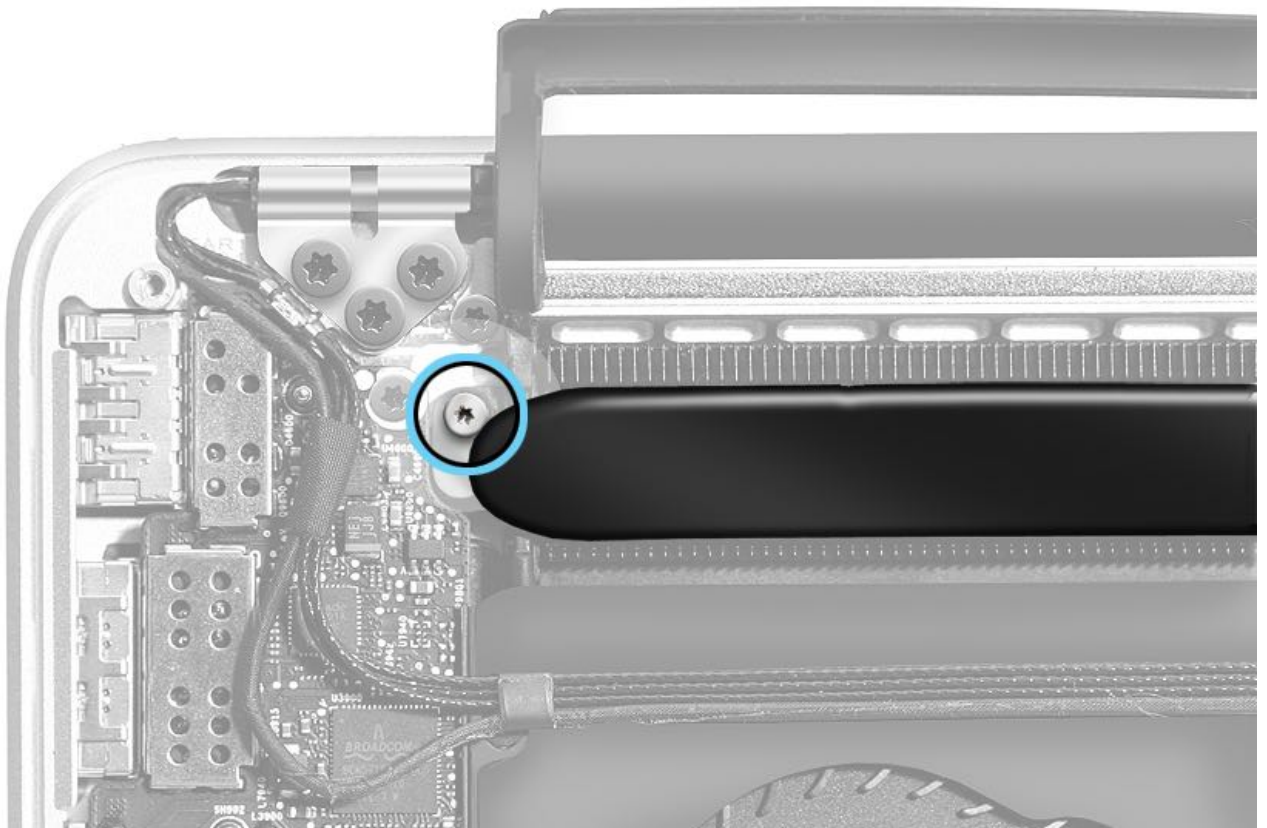
- One 923-0140 (2.0 mm)





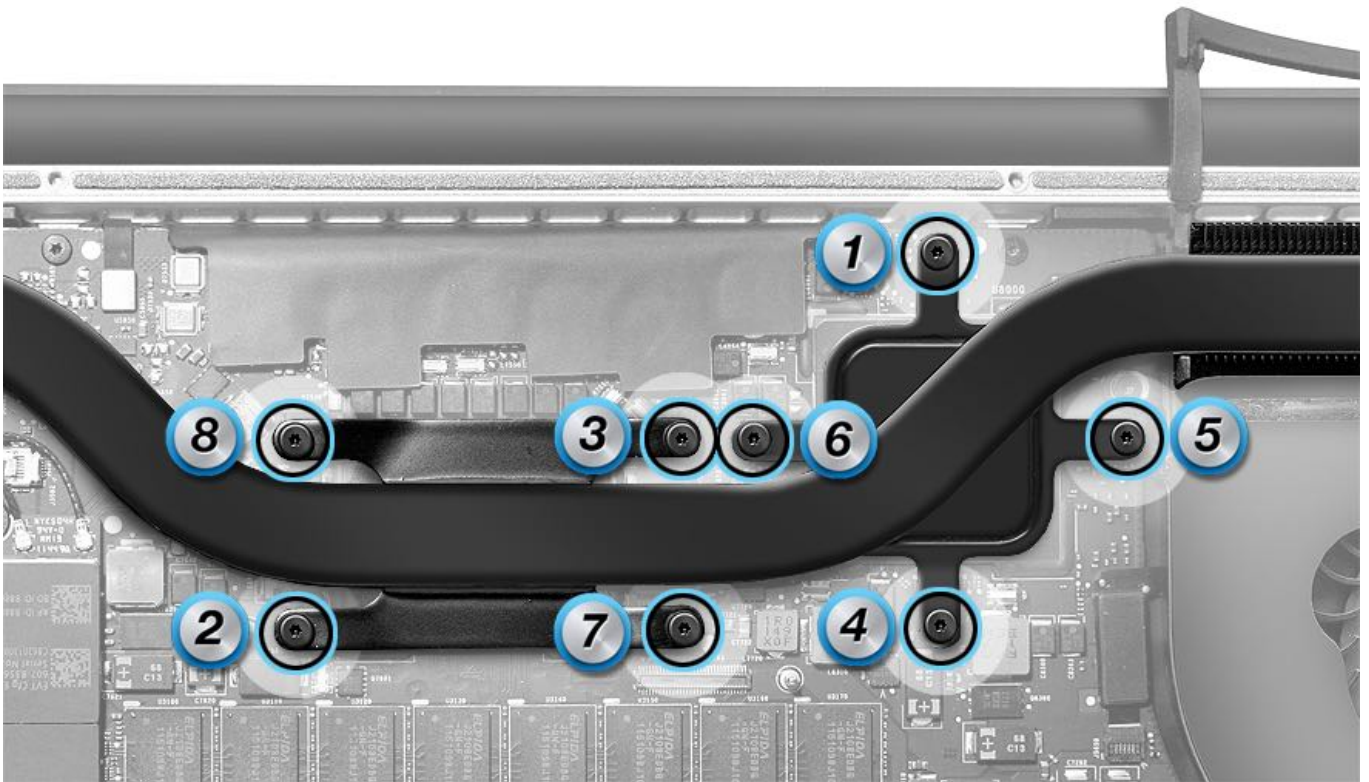
## Heat Sink

- One 923-0148 (2.95 mm)
- One 923-00538 (2.9 mm) (Mid 2015 only)



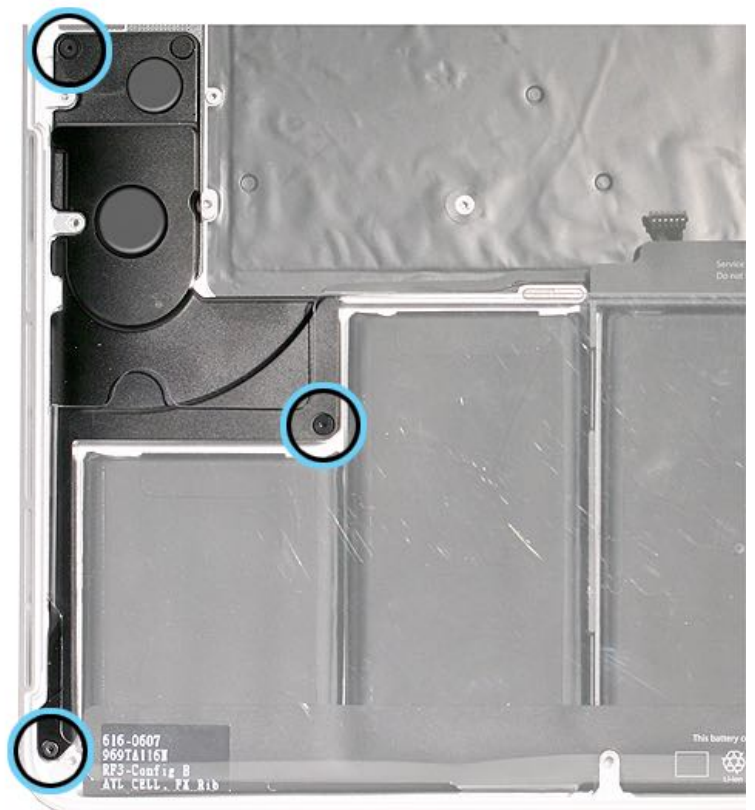
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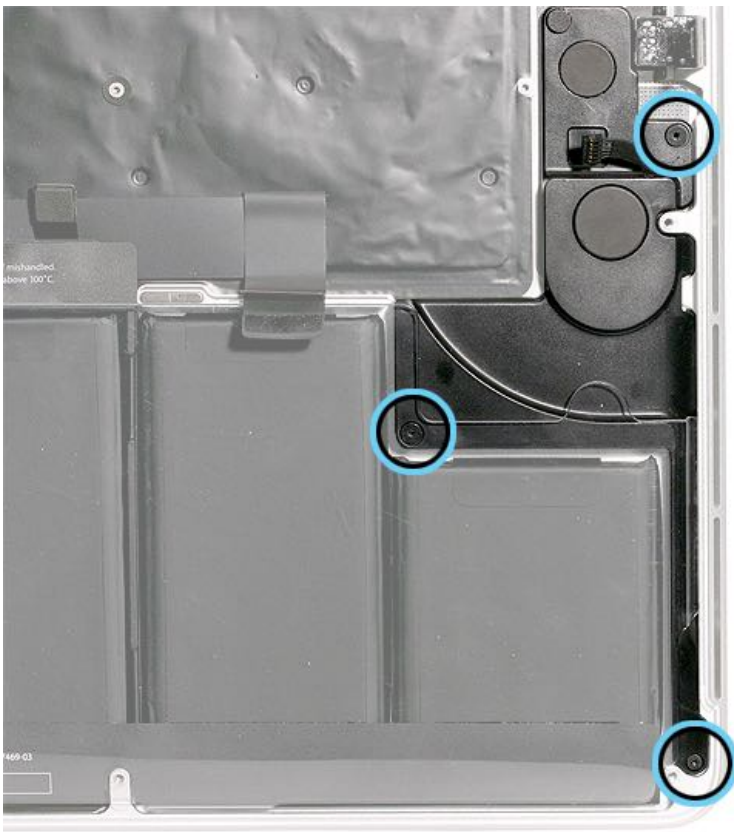


### Right and Left Speakers

- One 923-0143 (3.2 mm) (short, top)
- One 923-0146 (6.0 mm) (long shoulder, middle)
- One 923-0138 (5.42 mm) (medium, bottom)

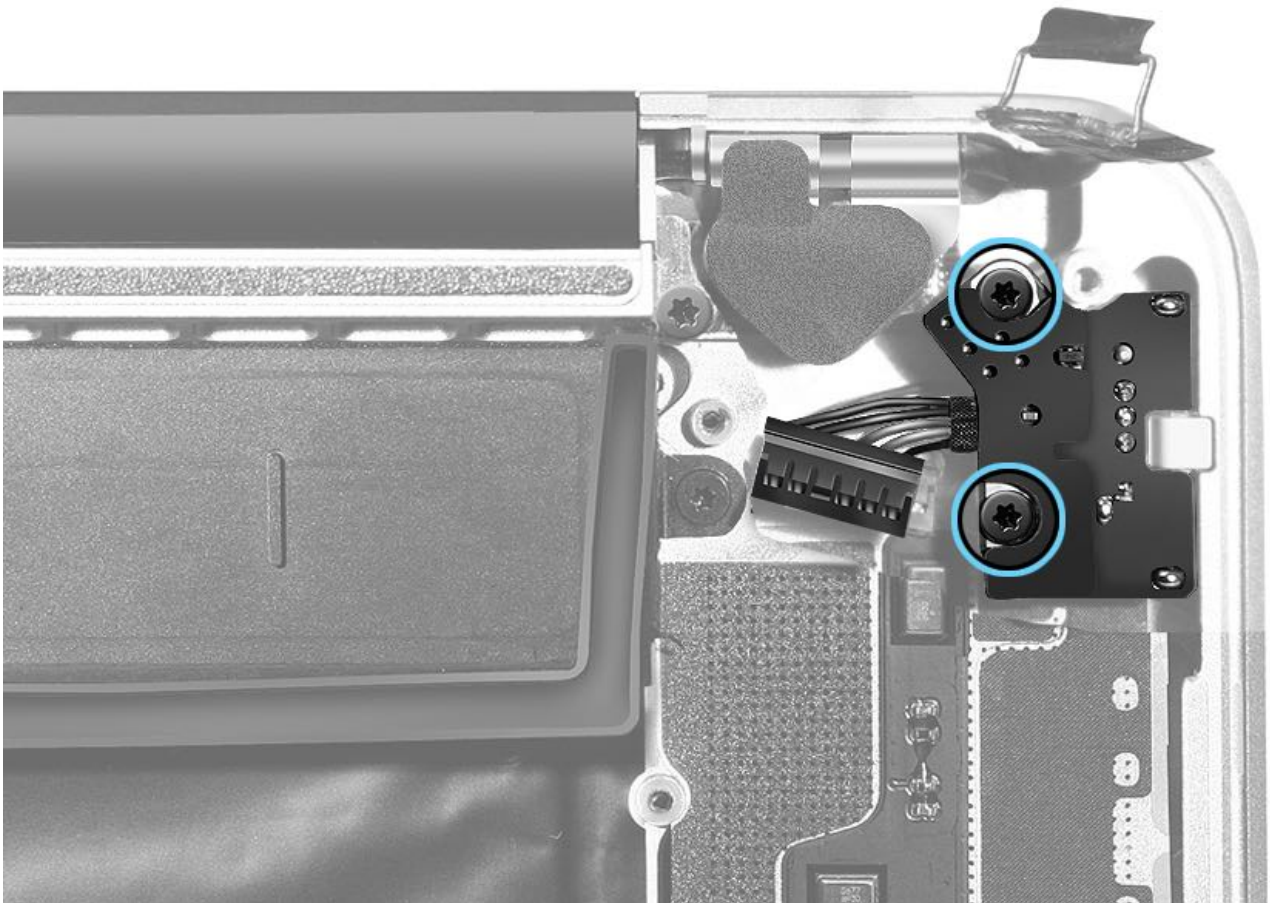






### MagSafe 2 Board

- Two 923-0144 (2.95 mm)



### Audio Board

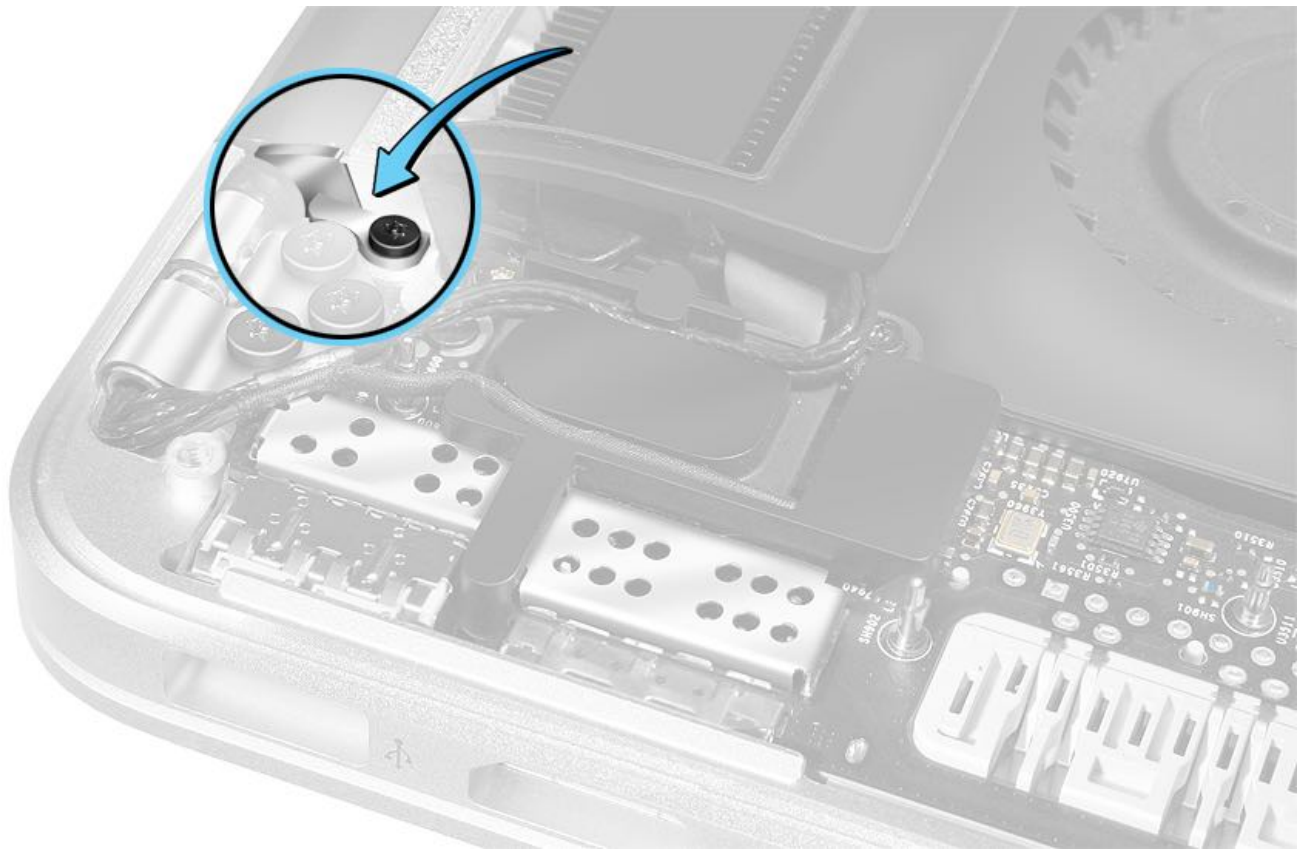


- One 923-0142 (3.0 mm)



### Display End Caps

- One 923-0135 (2.6 mm)



#### **Display Clutch Screws**

- Six 923-0139 (3.9 mm)

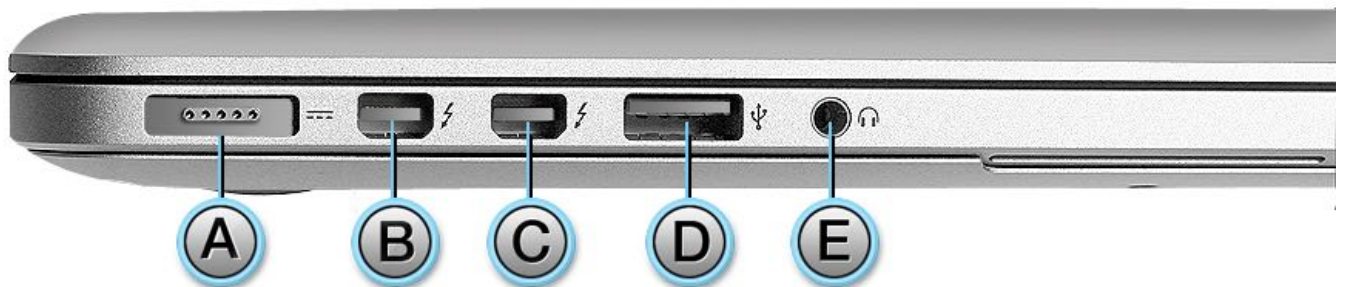
## External Views

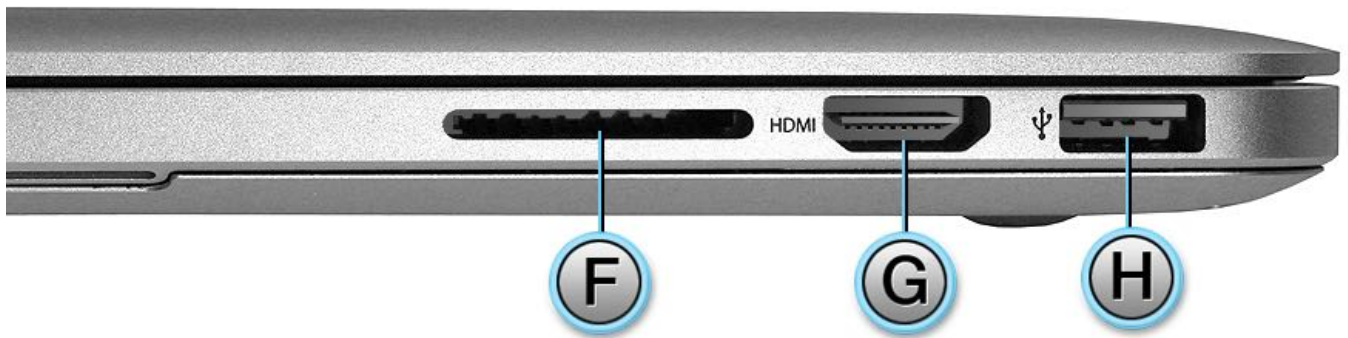
External Views for MacBook Pro (Retina, 15-inch, Mid 2012, Early 2013, Late 2013, Mid 2014, Mid 2015)

### Front View



### Port View





**A = MagSafe 2 power port**

**B & C = Thunderbolt (Mid 2012 and Early 2013) or Thunderbolt 2 (Late 2013, Mid 2014, and Mid 2015) ports**

**D = USB 3 port (compatible with USB 2)**

**E = Headphone (audio out)**

**F = SDXC card slot**

**G = HDMI port**

**H = USB 3 port (compatible with USB 2)**

### Bottom Case View

You can identify models by the EMC number on the bottom case:

- MacBook Pro (Retina, 15-inch, Mid 2012): EMC 2512
- MacBook Pro (Retina, 15-inch, Early 2013): EMC 2673, as shown
- MacBook Pro (Retina, 15-inch with Integrated Graphics, Late 2013): EMC 2674
- MacBook Pro (Retina, 15-inch with Discrete GPU, Late 2013): EMC 2745
- Macbook Pro (Retina, 15-inch with Integrated Graphics, Mid 2014): EMC 2876
- MacBook Pro (Retina, 15-inch with Discrete GPU, Mid 2014): EMC 2881
- MacBook Pro (Retina, 15-inch with Integrated Graphics, Mid 2015): EMC 2909
- MacBook Pro (Retina, 15-inch with Discrete GPU, Mid 2015): EMC 2910

